This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

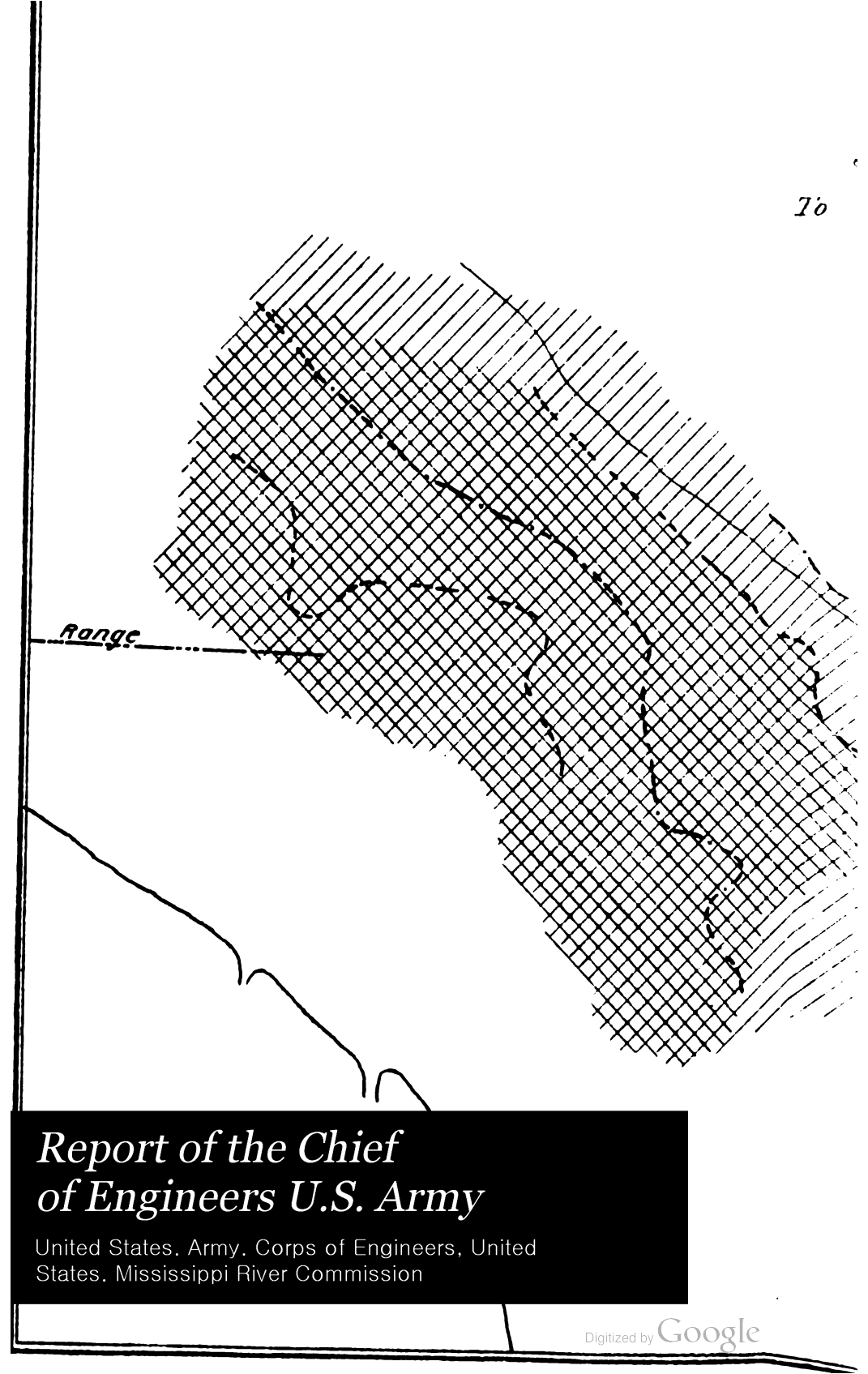
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

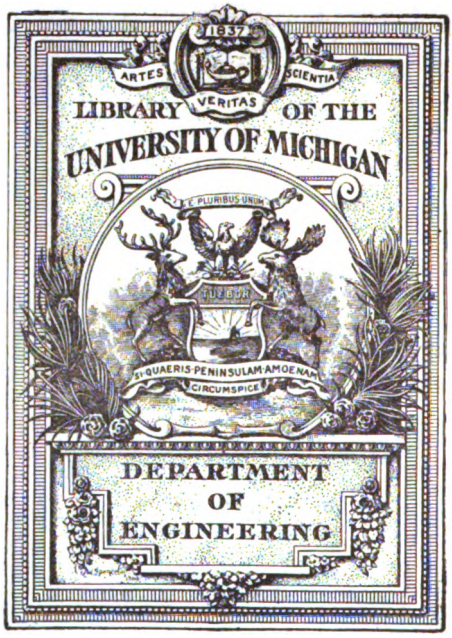
Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



Report of the Chief of Engineers U.S. Army

United States. Army. Corps of Engineers, United States. Mississippi River Commission

Digitized by Google



Digitized by Google

TA
23
.A3

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

52D CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 1, pt. 2, vol. II.

ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY,

TO THE

SECRETARY OF WAR,

FOR

THE YEAR 1891.

IN SIX PARTS.

PART III.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

Digitized by Google

Digitized by Google

CONTENTS.

[Alphabetical index will be found at the end of each part.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS.

CHANGES during year, distribution of officers, 3; officers detached, recommendations as to examinations for promotion, 4.

FORTIFICATIONS.

GENERAL STATEMENT, 4; defense of Boston Harbor, Mass., 6; defense of New York Harbor, N. Y., defense of Washington, D. C., 7; defense of Hampton Roads, Va., defense of San Francisco Harbor, Cal., 8.

PROTECTION OF SITE OF FORT NIAGARA, NEW YORK.

IN THE CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS 8

SEA WALL EMBANKMENT AT DAVIDS ISLAND, NEW YORK HARBOR.

IN THE CHARGE OF COL. D. C. HOUSTON, CORPS OF ENGINEERS 9

SEA WALLS AT GOVERNORS ISLAND, NEW YORK HARBOR.

IN THE CHARGE OF COL. D. C. HOUSTON, CORPS OF ENGINEERS 9

BEACH PROTECTION, WATER SUPPLY, AND SEWERAGE SYSTEM AT FORT MONROE, VIRGINIA.

IN THE CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS..... 10

REPAIR AND PRESERVATION OF FORT MARION, FLORIDA.

IN THE CHARGE OF CAPT. W. M. BLACK, CORPS OF ENGINEERS..... 11

ESTIMATES OF APPROPRIATIONS FOR FORTIFICATIONS REQUIRED FOR 1892-'93

..... 11

THE BOARD OF ENGINEERS.

OFFICERS constituting Board, summary of reports rendered, 11; additional duties of individual members, 14.

POST OF WILLETS POINT, NEW YORK.—UNITED STATES ENGINEER SCHOOL.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

OFFICER IN COMMAND, LIEUT. COL. W. R. KING, CORPS OF ENGINEERS—

Post of Willets Point, United States Engineer School, Battalion of the Corps of Engineers, 15; Engineer Depot, statement of funds, 16.

134785

Digitized by Google

RIVER AND HARBOR IMPROVEMENTS.

GENERAL STATEMENT, removal of wrecks, examinations and surveys, purchase of Portage Lake canals, Michigan, 17; harbor lines, bridges, 18; occupancy or injury of public works, engineer divisions, South Pass of the Mississippi River, 19.

ATLANTIC COAST AND GULF OF MEXICO.

IN THE CHARGE OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS—

St. Croix River, Me., Lubec Channel, Me., 19; Mooseabec Bar, Me., Pleasant River, Me., 20; Narraguagus River, Me., breakwater from Mount Desert to Porcupine Island, Me., 21; Bagaduce River, Me., 22; Penobscot River, Me., Belfast Harbor, Me., 23; Camden Harbor, Me., 24; Rockport Harbor, Me., Rockland Harbor, Me., 25; Kennebec River, Me., Harraseeket River, Me., 26; Portland Harbor, Me., channel in Back Cove, Portland, Me., 27; breakwater at mouth of Saco River, Me., Saco River, Me., 28; Kennebunk River, Me., York Harbor, Me., 29; Portsmouth Harbor, N. H., Bellamy River, N. H., 30; Cocheco River, N. H., harbor of refuge at Little Harbor, N. H., 31; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 32.

IN THE CHARGE OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS—

Newburyport Harbor, Mass., 33; Merrimac River, Mass., 34; Powow River, Mass., Ipswich River, Mass., 35; harbor of refuge, Sandy Bay, Cape Ann, Mass., Gloucester Harbor, Mass., 36; Manchester Harbor, Mass., 37; Salem Harbor, Mass., 38; Lynn Harbor, Mass., 39; Winthrop Harbor, Mass., Boston Harbor, Mass., 40; Weymouth River, Mass., Hingham Harbor, Mass., 42; Scituate Harbor, Mass., 43; Plymouth Harbor, Mass., Wellfleet Harbor, Mass., 44; Provincetown Harbor, Mass., 45; Chatham Harbor, Mass., examinations and surveys, 46.

IN THE CHARGE OF MAJ. W. R. LIVERMORE, CORPS OF ENGINEERS—

Harbor of refuge at Hyannis, Mass., harbor of refuge at Nantucket, Mass., 48; Marthas Vineyard inner harbor at Edgartown, Mass., 49; Vineyard Haven Harbor, Mass., Wareham Harbor, Mass., 50; New Bedford Harbor, Mass, 51; Westport Harbor, Mass., 52; Taunton River, Mass., 53; Pawtucket River, R. I., Providence River and Narragansett Bay, R. I., 54; removal of Green Jacket Shoal, Providence River, R. I., 55; Greenwich Bay, R. I., 56; cove and water-way near Coaster Harbor Island, R. I., Newport Harbor, R. I., 57; harbor of refuge at Point Judith, R. I., 58; harbor of refuge at Block Island, R. I., 59; Pawcatuck River, R. I. and Conn., harbor of refuge at Stonington, Conn., 60; removing sunken vessels or craft obstructing or endangering navigation, 61; examinations and surveys, 62.

IN THE CHARGE OF COL. D. C. HOUSTON, CORPS OF ENGINEERS—

Mystic River, Conn., Thames River, Conn., 63; New London Harbor, Conn., Connecticut River, Mass. and Conn., 64; Duck Island Harbor, Conn., Clinton Harbor, Conn., 66; New Haven Harbor, Conn., 67; breakwater at New Haven, Conn., 68; Milford Harbor, Conn., Housatonic River, Conn., 69; Bridgeport Harbor, Conn., Black Rock Harbor, Conn., 70; Norwalk Harbor, Conn., Wilson Point Harbor, Conn., 71; Five Mile River Harbor, Conn., Stamford Harbor, Conn., 72; Port Chester Harbor, N. Y., 73; Larchmont Harbor, N. Y., Echo Harbor, New Rochelle, N. Y., New Rochelle Harbor, N. Y., 74; East Chester Creek, N. Y., Greenport Harbor, N. Y., 75; harbor at Port Jefferson Inlet, N. Y., Huntington Harbor, N. Y., 76; Glen Cove Harbor, N. Y., Flushing Bay, N. Y., 77; Patchogue River, N. Y., 78; Brown's Creek, Sayville, N. Y., examinations and surveys, 79.

IN THE CHARGE OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS—

Hudson River, N. Y., 81; harbor at Saugerties, N. Y., 82; harbor at Rondout, N. Y., 83; Wappinger Creek, N. Y., Harlem River, N. Y., 84; removing obstructions in East River and Hell Gate, N. Y., 86; Newtown Creek, N. Y., 87; Buttermilk Channel, New York Harbor, 88; Gowanus Bay, N. Y., 89; New York Harbor, N. Y., 90; Raritan Bay, N. J., 92; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 93.

Digitized by Google

IN THE CHARGE OF CAPT. THOMAS L. CASEY, CORPS OF ENGINEERS—

Sumpawanus Inlet, N. Y., 94; Canarsie Bay, N. Y., 95; Sheepshead Bay, N. Y., 96; Arthur Kill, N. Y. and N. J., 97; channel between Staten Island and New Jersey, 98; Passaic River, N. J., 99; Elizabeth River, N. J., 100; Rahway River, N. J., 101; Raritan River, N. J., 102; South River, N. J., 103; Keyport Harbor N. J., Mattawan Creek, N. J., 104; Shoal Harbor and Compton Creek, N. J., 105; Shrewsbury River, N. J., Manasquan (Squan) River, N. J., 106; removing sunken vessels or craft obstructing or endangering navigation, examinations and survey, 107.

IN THE CHARGE OF MAJ. C. W. RAYMOND, CORPS OF ENGINEERS—

Delaware River, Pa. and N. J., 108; harbor between Philadelphia, Pa., and Camden, N. J., 110; Schuylkill River, Pa., 112; ice-harbor at Marcus Hook, Pa., ice-harbor at head of Delaware Bay, Del., 113; construction of iron pier in Delaware Bay near Lewes, Del., 114; harbor at Delaware Breakwater, Del., 115; Rancocas River, N. J., 116; Alloway Creek, N. J., Maurice River, N. J., 117; removal of wrecks from Delaware Bay and River, removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 118.

IN THE CHARGE OF WILLIAM F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED—

Wilmington Harbor, Del., 119; ice-harbor at New Castle, Del., 120; Appoquinnimink River, Del., Smyrna River, Del., 121; St. Jones River, Del., Mispillion Creek, Del., Broadkiln River, Del., 122; inland water-way from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 123; Susquehanna River, above and below Havre de Grace, Md., North East River, Md., 124; Elk River, Md., 125; Fairlee Creek, Md., Chester River, Md., from Crumpton to Jones Landing, 126; Choptank River, Md., Cambridge Harbor, Md., 127; Wicomico River, Md., 128; Manokin River, Md., Onancock Harbor, Va., 129; harbor at Cape Charles City, Va., and approaches by Chenton (Cherrystone) Inlet, 130; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 131.

IN THE CHARGE OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS—

Patapsco River and channel to Baltimore, Md., 132; James River, Va., 134; examination, 135.

IN THE CHARGE OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS—

Potomac River at Washington, D. C., 135; Potomac River at Mount Vernon, Va., Occoquan Creek, Va., 138; Aquia Creek, Va., 139; harbor at Breton Bay, Md., Nomini Creek, Va., 140; Patuxent River, Md., 141; Rappahannock River, Va., Urbana Creek, Va., 142; York River, Va., 143; Mattaponi River, Va., 144; Pamunkey River, Va., examinations and surveys, 145.

IN THE CHARGE OF CAPT. G. J. FIEBEGER, CORPS OF ENGINEERS—

Harbor of Norfolk, and its approaches, Va., 146; approach to Norfolk Harbor and the United States (Norfolk) navy-yard between Lambert Point and Fort Norfolk, 147; Hampton Creek and Bar, Va., Nansemond River, Va., 148; Chickahominy River, Va., 149; Appomattox River, Va., 150; inland water route from Norfolk Harbor, Va., to Albemarle Sound, N. C., through Currituck Sound, North Landing River, Va. and N. C., 151; Currituck Sound, Coanjok Bay, and North River Bar, N. C., examinations, 152.

IN THE CHARGE OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS—

Staunton River, Va., 153; Roanoke River, Va. and N. C., 154; Pasquotank River, N. C., Mackey Creek, N. C., 155; Ocracoke Inlet, N. C., Fishing Creek, N. C., 156; Pamlico and Tar rivers, N. C., 157; Contentnia Creek, N. C., Trent River, N. C., 158; Neuse River, N. C., 159; inland water-way between New Berne and Beaufort, N. C., 160; harbor at Beaufort, N. C., 161; inland water-way between Beaufort Harbor and New River, N. C., water-way between New River and Swansboro, N. C., 162; New River, N. C., 163; North East (Cape Fear) River, N. C., Black River, N. C., 164; Cape Fear River, N. C., above Wilmington, 165; Cape Fear River, N. C., at and below Wilmington, 166; Lockwood's Folly River, N. C., Yadkin River, N. C., 167; harbor at Georgetown, S. C., 168; Winyaw Bay, S. C., removing sunken vessels or craft obstructing or endangering navigation, 169; examinations, 170.

Digitized by Google

IN THE CHARGE OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS—

Waccamaw River to Waccamaw Lake, N. C. and S. C., 170; Lumber River, N. C. and S. C., Little Pedee River, S. C., 171; Great Pedee River, S. C., Clark River, S. C., 172; Mingo Creek, S. C., Santee River, S. C., 173; Wateree River, S. C., Congaree River, S. C., 174; Charleston Harbor, S. C., 175; Ashley River, S. C., Wappoo Cut, S. C., 176; Edisto River, S. C., 177; Salkahatchie River, S. C., Beaufort River, S. C., removing sunken vessels or craft obstructing or endangering navigation, 178; examination, 179.

IN THE CHARGE OF CAPT. O. M. CARTER, CORPS OF ENGINEERS—

Savannah River and Harbor, Ga., 179; Savannah River, Ga., Darien Harbor, Ga., 180; Altamaha River, Ga., Oconee River, Ga., 181; Ocmulgee River, Ga., Brunswick Harbor, Ga., 182; Jekyl Creek, Ga., 183; Cumberland Sound, Ga. and Fla., removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 184.

IN THE CHARGE OF CAPT. W. M. BLACK, CORPS OF ENGINEERS—

St. Johns River, Fla., 185; Ocklawaha River, Fla., 186; Volusia Bar, Fla., 187; harbor at St. Augustine, Fla., northwest entrance, Key West Harbor, Fla., 188; Caloosahatchee River, Fla., 189; channel of Charlotte Harbor and Pease Creek, Fla., 190; Sarasota Bay, Fla., Manatee River, Fla., 191; Tampa Bay, Fla., 192; Withlacoochee River, Fla., harbor at Cedar Keys, Fla., 193; Suwanee River, Fla., 194; examinations, 195.

IN THE CHARGE OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS—

Apalachicola Bay, Fla., 196; Apalachicola River, Fla., including Lee Slough, 197; Flint River, Ga., 198; Chattahoochee River, Ga. and Ala., 199; La Grange Bayou and Holmes River, Fla., 200; Choctawhatchee River, Fla. and Ala., 201; harbor at Pensacola, Fla., 202; Escambia and Conecuh rivers, Fla. and Ala., 203; Alabama River, Ala., 204; Tallapoosa River, Ala., 206; Coosa River, Ga. and Ala., 207; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., Cahaba River, Ala., 210; examinations, 211.

IN THE CHARGE OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS—

Mobile Harbor, Ala., 211; Warrior and Tombigbee rivers, Ala. and Miss., 212; Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 215; Noxubee River, Miss., Pascagoula River, Miss., 217; Chickasahay River, Miss., Bluff Creek, Miss., Leaf River, Miss., 218; harbor at Biloxi, Miss., Pearl River, Miss., below Jackson, 219; Pearl River, Miss., between Jackson and Carthage, Pearl River, Miss., between Edinburg and Carthage, Bogue Chitto, La., 220; examination, 221.

IN THE CHARGE OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS—

Inspection of the improvement of the South Pass of the Mississippi River, 221; Chefuncte (Tchefuncte) River and Bogue Falia, La., Tickfaw River and its tributaries, La., 222; Amite River and Bayou Manchac, La., 223; Bayou La Fourche, La., Bayou Terrebonne, La., 224; Bayou Plaquemine, La., Bayou Courtableau, La., 225; Bayou Teche, La., mouth and passes of Calcasieu River, La., 226; harbor at Sabine Pass, Tex., 227; Sabine River, Tex., Neches River, Tex., removing sunken vessels or craft obstructing or endangering navigation, 228; examinations and survey, 229.

IN THE CHARGE OF LIEUT. JOHN MILLIS, CORPS OF ENGINEERS—

Securing mouth of Bayou Plaquemine, La., from further caving, removing sunken vessels or craft obstructing or endangering navigation of New Orleans Harbor, La., 231.

IN THE CHARGE OF MAJ. CHARLES J. ALLEN, CORPS OF ENGINEERS—

Entrance to Galveston Harbor, Tex., 231; ship channel in Galveston Bay, Tex., 232; Trinity River, Tex., Cedar Bayou, Tex., 233; Buffalo Bayou, Tex., harbor at Brazos Santiago, Tex., 234; examinations and survey, 235.

Digitized by Google

WESTERN RIVERS.

IN THE CHARGE OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS—

Red River, La. and Ark., 236; Red River above Fulton, Ark., 237; Ouachita and Black rivers, Ark. and La., 238; Ouachita River above Camden, Ark., 239; Bayou D'Arbonne, La., Bayou Bartholomew, La. and Ark., 240; Bayou Bœuf (Bœuf River) La., Tensas River and Bayou Maçon, La., 241; bayous Rondeway and Vidal, La., Big Black River, Miss., 242; Yazoo River, Miss., 243; Tchula Lake, Miss., Tallahatchee River, Miss., Steele Bayou and Washington Bayou, Miss., 244; Big Sunflower River, Miss., 245; Big Hatchee River, Tenn., Forked Deer River, Tenn., water gauges on Mississippi River and its principal tributaries, 246; survey of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., 248; examinations, 249.

IN THE CHARGE OF CAPT. H. S. TABER, CORPS OF ENGINEERS—

Removing obstructions in Arkansas River, Ark., Ind. Ter., and Kans., 249; Arkansas River, Ark., Ind. Ter., and Kans., 250; Fourche River, Ark., 251; Petit Jean River, Ark., White River, Ark., 252; Cache River, Ark., 253; Little Red River, Ark., Black River, Ark. and Mo., 254; Black River, Mo., St. Francis River, Ark., 255; St. Francis River, Mo., Little River, Mo. and Ark., 256; examinations and survey, 257.

IN THE CHARGE OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS—

Examinations of Mississippi River, at Memphis Harbor, Tenn.; from Lake County, Tenn., to Fulton County, Ky., north and west of Reelfoot Lake, 257.

IN THE CHARGE OF MAJ. A. M. MILLER, CORPS OF ENGINEERS—

Removing snags and wrecks from Mississippi River, 258; Mississippi River between the Ohio and Illinois rivers, 259; harbor at St. Louis, Mo., 260; Gasconade River, Mo., 261; Osage River, Mo., 262; Kaskaskia River, Ill., 263.

IN THE CHARGE OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS—

Mississippi River between Des Moines Rapids and mouth of Illinois River, 263; examination, 264.

IN THE CHARGE OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS—

Operating snag boats and dredge boats on Upper Mississippi River, 264; Mississippi River between Minneapolis and Des Moines Rapids, 265; Des Moines Rapids, Mississippi River, operating and care of Des Moines Rapids Canal and Dry Dock, 266; examinations and survey, 267.

IN THE CHARGE OF MAJ. W. A. JONES, CORPS OF ENGINEERS—

Mississippi River above Falls of St. Anthony, Minn., reservoirs at headwaters of Mississippi River, 268; Chippewa River, including Yellow Banks, Wis., 270; St. Croix River, Wis. and Minn., Minnesota River, Minn., 271; Red River of the North, Minn. and N. Dak., 272; gauging Mississippi River at or near St. Paul, Minn., 273; examinations and survey, 274.

IN THE CHARGE OF LIEUT. COL. CHARLES R. SUTER, CORPS OF ENGINEERS—

Examination of Missouri River, from the old mouth of Platte River, Little Point, to a point opposite Leavenworth; and at Weston, Mo., 275.

IN THE CHARGE OF CAPT. CHAS. F. POWELL, CORPS OF ENGINEERS—

Missouri River between the Great Falls, Mont., and Sioux City, Iowa, 275; Yellowstone River, Mont. and N. Dak., 276; examinations and surveys, 277.

IN THE CHARGE OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS—

Tennessee River above Chattanooga, Tenn., and below Bee Tree Shoal, Ala., 278; Hiawassee River, Tenn., French Broad River, Tenn., 280; Clinch River, Tenn., 281; Cumberland River, Tenn. and Ky., 282; Caney Fork River, Tenn., 284; South Fork of Cumberland River, Ky., examinations and survey, 285.

Digitized by Google

IN THE CHARGE OF LIEUT. GEORGE W. GOETHALS, CORPS OF ENGINEERS—

Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., 286; operating and care of Muscle Shoals Canal, Tennessee River, 287; examination, 288.

IN THE CHARGE OF LIEUT. COL. WILLIAM E. MERRILL, CORPS OF ENGINEERS—

Ohio River, 288; operating snag boats on Ohio River, operating and care of Davis Island Dam, Ohio River, movable dam in Ohio River near mouth of Beaver River, Pa., Monongahela River, W. Va. and Pa., 290; operating and care of locks and dams Nos. 8 and 9, Monongahela River, purchase of Lock and Dam No. 7, Monongahela River, purchase of Lock and Dam No. 6, Monongahela River, Cheat River, W. Va., 291; Allegheny River, Pa., dam at Herr Island, Allegheny River, 292; ice-harbor at mouth of Muskingum River, Ohio, Muskingum River, Ohio, operating and care of locks and dams on Muskingum River, Ohio, 293; examinations, 294.

IN THE CHARGE OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS—

Falls of the Ohio River, Louisville, Ky., 295; Indiana Chute, Falls of the Ohio River, operating and care of Louisville and Portland Canal, Ky., 296; Wabash River, Ind. and Ill., 297; White River, Ind., examination, 298.

IN THE CHARGE OF COL. WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS—

Great Kanawha River, W. Va., 299; operating and care of locks and dams on Great Kanawha River, W. Va., Elk River, W. Va., 300; Gauley River, W. Va., 301; New River, from the mouth of Wilson, in Grayson County, Va., to the mouth of Greenbriar River, W. Va., 302; examination, 303.

IN THE CHARGE OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS—

Tradewater River, Ky., operating and keeping in repair locks and dams on Green and Barren rivers, Ky., 304; Rough River, Ky., Kentucky River, Ky., 305; operating and keeping in repair locks and dams on Kentucky River, Ky., Licking River, Ky., from Farmer to West Liberty, 306; Big Sandy River, W. Va. and Ky., Levisa Fork, Big Sandy River, Ky., 307; Tug Fork, Big Sandy River, W. Va. and Ky., Guyandotte River, W. Va., Little Kanawha River, W. Va., 308; Buckhannon River, W. Va., examinations, 309.

LAKE HARBORS AND RIVERS.

IN THE CHARGE OF CAPT. W. L. FISK, CORPS OF ENGINEERS—

Harbor at Grand Marais, Minn., 310; harbor at Agate Bay, Minn., harbor at Duluth, Minn., 311; harbor at Superior Bay and St. Louis Bay, Wis., 312; Minnesota Point, at Superior, Wis., harbor at Ashland, Wis., 313; harbor at Ontonagon, Mich., 314; Eagle Harbor, Mich., harbor at Marquette, Mich., 315; harbor of refuge at Grand Marais, Mich., resurvey and relocation of harbor line in Portage Lake, Houghton County, Mich., examinations and survey, 316.

IN THE CHARGE OF MAJ. CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS—

Manistique Harbor, Mich., 317; Cedar River Harbor, Mich., Menomonee Harbor, Mich. and Wis., Menomonee River, Mich. and Wis., 318; Oconto Harbor, Wis., Pensaukee Harbor, Wis., 319; Green Bay Harbor, Wis., 320; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., Ahnapee Harbor, Wis., 321; Kewaunee Harbor, Wis., Two Rivers Harbor, Wis., 322; Manitowoc Harbor, Wis., Sheboygan Harbor, Wis., 323; Port Washington Harbor, Wis., 324; harbor of refuge at Milwaukee Bay, Wis., Milwaukee Harbor, Wis., 325; Racine Harbor, Wis., Kenosha Harbor, Wis., 326; Waukegan Harbor, Ill., 327; Fox and Wisconsin rivers, Wis., 328; operating and care of locks and dams on Fox River, Wis., 329.

IN THE CHARGE OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS—

Chicago Harbor, Ill., 329; Calumet Harbor, Ill., 330; Calumet River, Ill. and Ind., 331; Illinois River, Ill., 332; operating and care of La Grange Lock, Illinois River, Ill., 333; Illinois and Mississippi Canal, 334; examination and survey, 335.

Digitized by Google

IN THE CHARGE OF MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS—

Petoskey Harbor, Mich., Charlevoix Harbor and entrance to Pine Lake, Mich., 336; Frankfort Harbor, Mich., harbor of refuge at Portage Lake, Mich., 337; Manistee Harbor, Mich., Ludington Harbor, Mich., 338; Pentwater Harbor, Mich., White River Harbor, Mich., 339; Muskegon Harbor, Mich., Grand Haven Harbor, Mich., 340; Holland (Black Lake) Harbor, Mich., 341; Saugatuck Harbor, Mich., South Haven Harbor, Mich., 342; St. Joseph Harbor, Mich., St. Joseph River, Mich., 343; Michigan City Harbor, Ind., 344; examination and survey, 345.

IN THE CHARGE OF COL. O. M. POE, CORPS OF ENGINEERS—

St. Marys River, Mich., 345; operating and care of St. Marys Falls Canal, Mich., dry dock at St. Marys Falls Canal, Mich., 346; Hay Lake Channel, St. Marys River, Mich., 347; harbor at Cheboygan, Mich., harbor at Thunder Bay, Mich., 348; Thunder Bay River, Mich., 350; harbor at Au Sable, Mich., Saginaw River, Mich., 351; harbor of refuge at Sand Beach, Lake Huron, Mich., 353; Black River at Port Huron, Mich., 354; mouth of Black River, Mich., 355; St. Clair Flats Canal, Mich., 356; operating and care of St. Clair Flats Canal, Mich., Clinton River, Mich., 358; Grosse Pointe Channel, Mich., 359; Rouge River, Mich., 360; Detroit River, Mich., removing sunken vessels or craft obstructing or endangering navigation, 361; examinations, 362.

IN THE CHARGE OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS—

Monroe Harbor, Mich., 363; Toledo Harbor, Ohio, 364; Port Clinton Harbor, Ohio, 365; Sandusky City Harbor, Ohio, Sandusky River, Ohio, 366; Huron Harbor, Ohio, 367; Vermillion Harbor, Ohio, 368; Black River Harbor, Ohio, 369; Cleveland Harbor, Ohio, 370; Fairport Harbor, Ohio, 371; Ashtabula Harbor, Ohio, 372; examinations and surveys, 373.

IN THE CHARGE OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS—

Erie Harbor, Pa., 373; preservation and protection of peninsula at Presque Isle, Erie Harbor, Pa., Dunkirk Harbor, N. Y., 374; Buffalo Harbor, N. Y., 375; Tonawanda Harbor and Niagara River, N. Y., Wilson Harbor, N. Y., 376; Olcott Harbor, N. Y., Oak Orchard Harbor, N. Y., 377; examination and survey, 378.

IN THE CHARGE OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS—

Charlotte Harbor, N. Y., 378; Pultneyville Harbor, N. Y., 379; harbor at Great Sodus Bay, N. Y., harbor at Little Sodus Bay, N. Y., 380; Oswego Harbor, N. Y., 381; harbor at Sacketts Harbor, N. Y., 382.

IN THE CHARGE OF MAJ. M. B. ADAMS, CORPS OF ENGINEERS—

Shoal between Sister Islands and Cross-over Light, St. Lawrence River, N. Y., Ogdensburg Harbor, N. Y., 383; Grass River, N. Y., breakwater at Rouse Point, Lake Champlain, N. Y., 384; Great Chazy River, N. Y., breakwater at Gordon Landing, Lake Champlain, Vt., Plattsburg Harbor, N. Y., 385; Burlington Harbor, Vt., Otter Creek, Vt., 386; Ticonderoga River, N. Y., Narrows of Lake Champlain, N. Y. and Vt., 387; examinations, 388.

PACIFIC COAST.

IN THE CHARGE OF COL. G. H. MENDELL, CORPS OF ENGINEERS—

Oakland Harbor, Cal., 388; survey of San Francisco Harbor, San Pablo and Suisun bays, Strait of Carquinez, and mouths of San Joaquin and Sacramento rivers, Cal., 389.

IN THE CHARGE OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS—

Napa River, Cal., 389; Redwood Harbor, Cal., Redwood Creek, Cal., 390; San Luis Obispo Harbor, Cal., Wilmington Harbor, Cal., 391; San Diego Harbor, Cal., 392; examinations, 393.

IN THE CHARGE OF MAJ. W. H. HEUER, CORPS OF ENGINEERS—

San Joaquin River, Cal., 394; Mokelumne River, Cal., 395; Sacramento and Feather rivers, Cal., 396; Petaluma Creek, Cal., Humboldt Harbor and Bay, Cal., 397; examination and survey, investigation of mining-débris question in State of California, 399.

Digitized by Google

IN THE CHARGE OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS—

Coquille River, Oregon, 399; entrance to Coos Bay and Harbor, Oregon, 401; Umpqua River, Oregon, Siuslaw River, Oregon, 402; Yaquina Bay, Oregon, 403; Tillamook Bay and Bar, Oregon, 404; Nehalem Bay, Oregon, Upper Columbia and Snake rivers, Oregon and Wash., 405; Columbia River between head of Rock Island Rapids and foot of Priest Rapids, Wash., 406; Chehalis River, Wash., 407; Skagit, Stellaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 408; examinations and surveys, 409.

IN THE CHARGE OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS—

Mouth of Columbia River, Oregon and Wash., 412; construction of canal at the Cascades, Columbia River, Oregon, 414; Columbia and Lower Willamette rivers below Portland, Oregon, 416; Willamette River above Portland, Oregon, 417; Cowlitz River, Wash., 418; Young's and Klaskuine rivers, Oregon, gauging waters of Columbia River, Oregon and Wash., 419; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 420.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS 421

SUPERVISION OF THE HARBOR OF NEW YORK 422

MISSISSIPPI RIVER COMMISSION..... 422

MISSOURI RIVER COMMISSION..... 423

HARBOR LINES 423

Lubec, Me., Kennebec River at Bath, Me., Boston Harbor, Mass., New York Harbor and its adjacent waters, 424; Philadelphia, Pa., New Castle, Del., St. Augustine Harbor, Fla., 425; Duluth Harbor, Bay of St. Louis, Superior Bay and adjacent waters, Minn. and Wis., Portage Lake, Mich., Chicago Harbor, Ill., San Francisco Harbor and adjacent waters, Cal., San Pedro, Wilmington Harbor, Cal., 426; Humboldt Bay, Cal., Astoria Harbor, Oregon, 427.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

(1) Bridge of Winona and Southwestern Railway Company across Mississippi River at Winona, Minn.; (2) bridge across Powow River, between the towns of Amesbury and Salisbury, Mass., 427; (3) bridge of Clinton and Illinois Bridge Company across Mississippi River near Clinton, Iowa; (4) bridge of Leavenworth and Platte County Bridge Company across Missouri River between Leavenworth, Kans., and Platte County, Mo., 428; (5) bridge of Charleston and South Side Bridge Company across Great Kanawha River at Charlestown, W. Va.; (6) bridge of Oregon Railway Extensions Company across Columbia River near Vancouver, Wash.; (7) bridge of The South Bound Railroad Company across Savannah River near Sister Ferry, Effingham County, Ga.; (8) bridge of Houston, Central Arkansas and Northern Railroad Company across Little River, La.; (9) bridge of Wrightsville and Tennille (Tennville) Railroad Company across Oconee River near Dublin, Ga., 429; (10) bridge of Houston, Central Arkansas and Northern Railroad Company across Ouachita River near Columbia, La.; (11) bridge of Kansas City Terminal Railway Company across Missouri River near Quindaro, Kans.; (12) bridge of city of St. Paul, Minn., across Mississippi River at St. Paul, Minn.; (13) bridge of Cable City Bridge Construction Company across Arkansas River at Dardanelle, Ark.; (14) bridge of Houston, Central Arkansas and Northern Railroad Company across Red River at Upper Falls, near Alexandria, La.; (15) bridge of Macon, Dublin and Savannah Railroad Company across Oconee River at Dublin, Ga.; (16) bridges of Tacoma, Olympia and Grays Harbor Railroad Company across Chehalis River between Aberdeen and Cosmopolis, Wash., and across Johns River near its confluence with Grays Harbor, Wash., 430; (17) bridges of Norfolk and Western Railroad Company across Tug Fork of Big Sandy River, 91 and 95¼ miles above Catlettsburg, Ky.; (18) bridge of Port View Bridge Company across Youghiogheny River at McKeesport, Pa.; (19) bridge of Inter-State Bridge and Street Railway Company across Missouri River between Council Bluffs, Iowa, and East Omaha, Nebr.; (20) bridge of Northern Pacific and Puget Sound Shore Railroad Company across Duwamish (D'Wamish) River near Seattle, Wash.; (21) bridge of Spokane

Digitized by Google

and Palouse Railway Company across Clearwater River, about 11 miles above Lewiston, Idaho; (22) bridge of Allegheny Bridge Company across Allegheny River, at Sixth street, Pittsburg, Pa.; (23) bridge of Messrs. Frederick W. Dickinson *et al.* across channel separating Little Island from mainland at Osterville, in town of Barnstable, Mass.; (24) bridge of city of Winona, Minn., across Mississippi River at Winona, Minn., 431; (25) bridge of Missouri River and Land Improvement and Construction Company across Missouri River near mouth of Kansas River; (26) bridge of Coos Bay, Roseburg and Eastern Railroad and Navigation Company across Coal Bank Slough, in Coos County, Oregon; (27) bridge of St. Clair, Madison and St. Louis Belt Railroad Company across Mississippi River at Alton, Ill.; (28) temporary and permanent bridges of Chicago and North-Western Railway Company across North Branch of Chicago River near Kinzie street, Chicago, Ill.; (29) bridge of The Upper Bridge Company across Monongahela River near Pittsburg, Pa.; (30) bridge of Chicago and North Michigan Railroad Company across Pine Lake, near Charlevoix, Mich.; (31) bridge of commissioners of public parks of the city of New York across Harlem River at 155th street and McComb Dam Road, New York City, 432; (32) bridge of North River Bridge Company across Hudson River at New York City, 433.

BRIDGES OBSTRUCTING NAVIGATION.

(1) Bridge across Ashley River, S. C.; (2) bridge across Swinomish Slough, Wash., 433; (3) bridge across Green River (below Lock No. 1), at Spottsville, Ky.; (4) bridge across Muskingum River, between Marietta and Harmar, Ohio; (5) bridge across Muskingum River, between Taylorsville and Duncan Falls, Ohio; (6) bridge across canal of Muskingum River at foot of Main street, Zanesville, Ohio; (7) bridge across Bayou Plaquemine, La., 434; (8) bridge across channel leading to Back Cove, Portland Harbor, Me.; (9) bridge across Savannah River below Augusta, Ga.; (10) bridge across Tennessee River at Florence, Ala.; (11) bridge across Little Tennessee River, near Niles Ferry, Tenn.; (12) bridge across Spuyten Duyvil Creek, N. Y.; (13) bridge across Trout Creek, Fla., 435; (14) bridge across Chicago River at Canal street, Chicago, Ill.; (15) bridge across Kentucky River at Frankfort, Ky., 436.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS..... 436

MISCELLANEOUS.

WASHINGTON AQUEDUCT.

IN THE CHARGE OF LIEUT. COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS—

Washington Aqueduct, 436; water supply, District of Columbia, 441; increasing the water supply of Washington, D. C., 442; erection of fishways at Great Falls, 443.

PUBLIC BUILDINGS AND GROUNDS AND WASHINGTON MONUMENT, DISTRICT OF COLUMBIA.

IN THE CHARGE OF COL. O. H. ERNST, MAJOR, CORPS OF ENGINEERS 444

SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES.

SURVEY at Marquette Harbor, Mich., 445.

PRINTING AND DISTRIBUTION OF CHARTS OF THE NORTHERN AND NORTHWESTERN LAKES 445

CONSTRUCTION AND IMPROVEMENT OF ROADS AND BRIDGES IN YELLOWSTONE NATIONAL PARK.

IN THE CHARGE OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS 447

MILITARY AND OTHER MAPS..... 449

Digitized by Google

RECONNAISSANCES AND EXPLORATIONS.

OFFICERS on duty at headquarters of military divisions and departments, operations in Division of the Missouri, 449; operations in Department of the Columbia, Department of the Platte, Division of the Pacific, 450.

ESTIMATES FOR AMOUNTS REQUIRED FOR SURVEYS AND RECONNAISSANCES IN MILITARY DEPARTMENTS, AND FOR MAPS, INCLUSIVE OF WAR MAPS 450

OFFICE OF THE CHIEF OF ENGINEERS.

OFFICERS in charge of divisions, 451.

STATEMENT SHOWING RANK AND DUTIES OF OFFICERS OF THE CORPS OF ENGINEERS DURING THE FISCAL YEAR ENDING JUNE 30, 1891 .. 453

LAWS AFFECTING THE CORPS OF ENGINEERS, FIFTY-FIRST CONGRESS, SECOND SESSION, 1890–'91 477

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

PROTECTION of site of Fort Niagara, N. Y., 517.

APPENDIX No. 2.

REPORT OF COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Sea wall and embankment at Davids Island, New York Harbor, 521; sea walls on Governors Island, New York Harbor, 524.

APPENDIX No. 3.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Beach protection at Fort Monroe, Va., 529; water supply at Fort Monroe, Va., 530; sewerage system at Fort Monroe, Va., 531.

APPENDIX No. 4.

REPORT OF CAPT. W. M. BLACK, CORPS OF ENGINEERS.

REPAIR and preservation of Fort Marion, St. Augustine, Fla., 533.

APPENDIX No. 5.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

POST of Willets Point, N. Y., 537; United States Engineer School, 539; Battalion of Engineers, 540; Engineer Depot, 547; experiments, 550; statement of funds, 551; estimates, 553. Appendixes: B, programme of study and instruction for winter season, 553; C, programme of study and instruction for summer season, 556; D, tests of explosives, 559; E, tests of building materials, 565.

Digitized by Google

RIVERS AND HARBORS, ETC.

APPENDIX A.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Croix River, Me., 570; Lubec Channel, Me., 571; Mooseabec Bar, Me., 572; Pleasant River, Me., 573; Narraguagus River, Me., 574; breakwater from Mount Desert to Porcupine Island, Me., 576; Bagaduce River, Me., 578; Penobscot River, Me., 579; Belfast Harbor, Me., 586; Camden Harbor, Me., 587; Rockport Harbor, Me., 588; Rockland Harbor, Me., 589; Kennebec River, Me., 590; Harraseeket River, Me., 594; Portland Harbor, Me., 595; channel in Back Cove, Portland, Me., 597; breakwater at mouth of Saco River, Me., 598; Saco River, Me., 599; Kennebunk River, Me., 601; York Harbor, Me., 602; Portsmouth Harbor, N. H., 604; Bellamy River, N. H., 605; Cocheco River, N. H., 607; harbor of refuge at Little Harbor, N. H., 608; removing sunken vessels or craft obstructing or endangering navigation, 609.
EXAMINATIONS.—Harbor of Blue Hill, Me., 611; Pepperell Cove, Me., 614; Lubec Channel, Me., 616; Sullivan Falls, Me., 619.
HARBOR LINES.—Establishment of harbor lines at Lubec, Me., 621; establishment of harbor lines in Kennebec River at Bath, Me., 622.

APPENDIX B.

REPORT OF LIEUT. COL. S. M. MANSFIELD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Newburyport Harbor, Mass., 626; Merrimac River, Mass., 628; Powow River, Mass., 630; Ipswich River, Mass., 631; harbor of refuge, Sandy Bay, Cape Ann, Mass., 632; Gloucester Harbor, Mass., 635; Manchester Harbor, Mass., 638; Salem Harbor, Mass., 639; Lynn Harbor, Mass., 641; Winthrop Harbor, Mass., 644; Boston Harbor, Mass., 645; Weymouth River, Mass., 655; Hingham Harbor, Mass., 656; Scituate Harbor, Mass., 658; Plymouth Harbor, Mass., 660; Wellfleet Harbor, Mass., 663; Provincetown Harbor, Mass., 665, Chatham Harbor, Mass., 667.
EXAMINATIONS AND SURVEYS.—North River, Salem, Mass., 668; shoals at the mouth of North River, Mass., 670; Mystic and Malden rivers, Mass., 672; Essex River, Mass., 676; Town River, Mass., 679; Weymouth Back River, Mass., 682; Kingston Harbor, Mass., 685.
HARBOR LINES.—Establishment of harbor lines in Boston Harbor, Mass., 688.

APPENDIX C.

REPORT OF MAJ. W. R. LIVERMORE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 694; harbor of refuge at Nantucket, Mass. 696; Marthas Vineyard, inner harbor at Edgartown, Mass., 698; Vineyard Haven Harbor, Mass., 700; Wareham Harbor, Mass., 701; New Bedford Harbor, Mass., 704; Westport Harbor, Mass., 706; Taunton River, Mass., 707; Pawtucket River, R. I., 709; Providence River and Narragansett Bay, R. I., 712; removal of Green Jacket Shoal, Providence River, R. I., 715; Greenwich Bay, R. I., 716; cove and water way near Coaster Harbor Island, R. I., 718; Newport Harbor, R. I., 719; harbor of refuge at Point Judith, R. I., 722; harbor of refuge at Block Island, R. I., 723; Pawcatuck River, R. I. and Conn., 726; harbor of refuge at Stonington, Conn., 728; removing sunken vessels or craft obstructing or endangering navigation, 731.
EXAMINATIONS.—Narragansett Bay Channel, R. I., between Starve Goat Island and the mainland, 733; Watch Hill Cove, R. I., 735; Newport Harbor, R. I., south of Goat Island, 736.

Digitized by Google

APPENDIX D.

REPORT OF COL. D. C. HOUSTON, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mystic River, Conn., 740; Thames River, Conn., 742; New London Harbor, Conn., 746; Connecticut River, Mass. and Conn., 748; harbor of refuge at Duck Island Harbor, Conn., 757; Clinton Harbor, Conn., 759; New Haven Harbor, Conn., 761; breakwater at New Haven, Conn., 766; Milford Harbor, Conn., 770; Housatonic River, Conn., 773; Bridgeport Harbor, Conn., 778; Black Rock Harbor, Conn., 784; Norwalk Harbor, Conn., 786; harbor at Wilson Point, Conn., 789; Five Mile River Harbor, Conn., 792; Stamford Harbor, Conn., 795; Port Chester Harbor, N. Y., 797; Larchmont Harbor, N. Y., 800; Echo Harbor, New Rochelle, N. Y., 802; New Rochelle Harbor, N. Y., 804; East Chester Creek, N. Y., 806; Greenport Harbor, N. Y., 811; Port Jefferson Harbor, N. Y., 814; Huntington Harbor, N. Y., 817; Glen Cove Harbor, N. Y., 820; Flushing Bay, N. Y., 822; Patchogue River, N. Y., 825; Browns Creek, Sayville, N. Y., 828.

EXAMINATIONS AND SURVEYS.—Stony Creek River at Stony Creek, Conn., 831; Shaw Cove, New London Harbor, Conn., 833; Connecticut River, below Hartford, Conn., 836; Saugatuck River, Conn., 840; Mattituck Bay, N. Y., 843; Stamford Harbor, Conn., 848; Cos Cob or Miamus River, Conn., 852; Peconic River, N. Y., 855; Sag Harbor, N. Y., 859.

APPENDIX E.

REPORT OF LIEUT. COL. G. L. GILLESPIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Hudson River, N. Y., 864; harbor at Saugerties, N. Y., 879; harbor at Rondout, N. Y., 882; Wappinger Creek, N. Y., 885; Harlem River, N. Y., 886; removing obstructions in East River and Hell Gate, N, Y., 899; Newtown Creek, N. Y., 906; Buttermilk Channel, New York Harbor, 911; Gowanus Bay, N. Y., 914; New York Harbor, N. Y., 922; Raritan Bay, N. J., 931; removing sunken vessels or craft obstructing or endangering navigation, 937.

EXAMINATIONS AND SURVEYS.—Buttermilk and Gowanus Bay Channels, New York Harbor, 937; Bay Ridge Channel, N. Y., 940; Champlin Creek, N. Y., 942; Hudson River and Moodna River (Murderers Creek) at Cornwall, N. Y., 944; Bronx River, N. Y., 949; Westchester Creek, N. Y., 954.

HARBOR LINES.—Establishment of harbor lines in New York Harbor and its adjacent waters, 958.

PART II.

APPENDIX F.

REPORT OF CAPT. THOS. L. CASEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Sumpawanus Inlet, N. Y., 978; Canarsie Bay, N. Y., 980; Sheepshead Bay, N. Y., 982; Arthur Kill, N. Y. and N. J., 983; channel between Staten Island and New Jersey, 986; Passaic River, N. J., 988; Elizabeth River, N. J., 993; Rahway River, N. J., 995; Raritan River, N. J., 996; South River, N. J., 999; Keyport Harbor, N. J., 1001; Mattawan Creek, N. J., 1003; Shoal Harbor and Compton Creek, N. J., 1004; Shrewsbury River, N. J., 1007; Manasquan (Squan) River, N. J., 1010; removing sunken vessels or craft obstructing or endangering navigation, 1013.

EXAMINATIONS AND SURVEY.—Princess Bay, Staten Island, N. Y., 1013; Hackensack River, N. J., 1016.

APPENDIX G.

REPORT OF MAJ. C. W. RAYMOND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River, Pa. and N. J., 1022; harbor between Philadelphia Pa., and Camden, N. J., 1029; Schuylkill River, Pa., 1069; ice-harbor at Marcus Hook, Pa., 1072; ice-harbor at head of Delaware Bay, Del., 1072; construction of iron pier in Delaware Bay, near Lewes, Del., 1073; harbor at Delaware Breakwater, Del., 1075; Rancocas River, N. J., 1084; Alloway Creek, N. J., 1086; Maurice River, N. J., 1088; removal of wrecks from Delaware Bay and River, 1090; removing sunken vessels or craft obstructing or endangering navigation, 1090.

Digitized by Google

EXAMINATIONS AND SURVEYS.—Shark River, N. J., 1092; sound between Barnegat Bay and Great Egg Harbor Bay, N. J., 1093; Little Egg Harbor Bay and Inlet, including Great Bay, N. J., 1095; thoroughfare from Cape May to the Great Bay north of Atlantic City, N. J., 1097; Cape May City, N. J., 1099; Pensauken Creek, N. J., 1100; West Branch of Susquehanna River, Pa., 1102; Toms River, N. J., 1114; Goshen Creek, N. J., 1116; harbor of refuge near mouth of Delaware Bay, 1120.
HARBOR LINES.—Establishment of harbor lines in port of Philadelphia, 1121.

APPENDIX H.

REPORT OF WM. F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, U. S. ARMY, RETIRED.

IMPROVEMENTS.—Wilmington Harbor, Del., 1136; ice-harbor at New Castle, Del., 1160; Appoquinnimink River, Del., 1161; Smyrna River, Del., 1162; St. Jones River, Del., 1165; Mispillion Creek, Del., 1166; Broadkiln River, Del., 1167; inland water way from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 1168; Susquehanna River, above and below Havre de Grace, Md., 1181; North East River, Md., 1182; Elk River, Md., 1184; Fairlee Creek, Md., 1186; Chester River, Md., from Crumpton to Jones Landing, 1188; Choptank River, Md., 1189; Cambridge Harbor, Md., 1191; Wicomico River, Md., 1193; Manokin River, Md., 1195; Onancock Harbor, Va., 1197; harbor at Cape Charles City, Va., and approaches by Chenton (Cherrystone) Inlet, 1199; removing sunken vessels or craft obstructing or endangering navigation, 1201.
EXAMINATIONS AND SURVEYS.—Linchester River, Md., 1202; Northwest Fork of Nanticoke River, Md., 1204; Tangier Harbor, Va., 1207; Broad Creek River, Del., 1209; Turner Creek, Md., 1211; La Trappe River, Md., 1215; Warwick River, Md., 1218; Broad Creek, Md., 1221.
HARBOR LINES.—Establishment of harbor lines at New Castle, Del., 1225.

APPENDIX I.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 1227; James River, Va., 1234.
EXAMINATION.—Patapsco River, Md., from the Craighill Channel to the sugar refinery wharves, Curtis Bay, 1243.

APPENDIX J.

REPORT OF LIEUT. COL. PETER C. HAINS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Potomac River at Washington, D. C., 1246; Potomac River at Mt. Vernon, Va., 1252; Occoquan Creek, Va., 1253; Aquia Creek, Va., 1255; harbor at Breton Bay, Md., 1258; Nomini Creek, Va., 1259; Patuxent River, Md., 1262; Rappahannock River, Va., 1264; Urbana Creek, Va., 1268; York River, Va., 1270; Mattaponi River, Va., 1273; Pamunkey River, Va., 1275.
EXAMINATIONS.—St. Leonard Creek, Md., 1277; St. Jerome Bay, Md., 1278; Piscataway Creek, Md., 1279; Newport Creek, head of Wicomico River, Md., 1281; Smith Creek, Md., 1282; Nandua Creek, Va., 1283; Potomac Creek, Va., 1285; Upper Machodoc Creek, Va., 1286; Great Wicomico River, Va., 1288; Crane Creek, Va., 1289; Piscataway Creek, Va., 1289.

APPENDIX K.

REPORT OF CAPT. G. J. FIEBEGER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of Norfolk and its approaches, Va., 1291; approach to Norfolk Harbor and the United States navy-yard at Norfolk, Va., 1296; Hampton Creek and Bar, Va., 1297; Nansemond River, Va., 1298; Chickahominy River, Va., 1299; Appomattox River, Va., 1300; inland water route from Norfolk Harbor, Va., to Albemarle Sound, N. C., through Currituck Sound, 1302; North Landing River, Va. and N. C., 1304; Currituck Sound, Coanjok Bay, and North River Bar, N. C., 1305.

Digitized by Google

EXAMINATIONS.—Chickahominy River, from Holly Landing to Long Bridge, Va., 1305; western branch of Elizabeth River, Va., 1307; water way to connect Lynn Haven Bay with eastern branch of Elizabeth River, Va., 1310; Nottoway River, from mouth of river to Courtland, Va., 1315; North-West River, N. C., up to Moyock, 1321; West Neck River, to and beyond Dozier Bridge, Va., 1324.

APPENDIX L.

REPORT OF CAPT. W. H. BIXBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Staunton River, Va., 1328; Roanoke River, Va. and N. C., 1330; Pasquotank River, N. C., 1335; Mackey Creek, N. C., 1339; Ocracoke Inlet, N. C., 1341; Fishing Creek, N. C., 1345; Pamlico and Tar rivers, N. C., 1347; Contentnia Creek, N. C., 1351; Trent River, N. C., 1355; Neuse River, N. C., 1358; inland water way between New Berne and Beaufort, N. C., 1363; harbor at Beaufort, N. C., 1367; inland water way between Beaufort Harbor and New River, N. C., 1372; water way between New River and Swansboro, N. C., 1376; New River, N. C., 1379; North East (Cape Fear) River, N. C., 1383; Black River, N. C., 1387; Cape Fear River, N. C., above Wilmington, 1390; Cape Fear River, N. C., at and below Wilmington, 1394; Lockwoods Folly River, N. C., 1402; Yadkin River, N. C., 1404; harbor at Georgetown, S. C., 1408; Winyaw Bay, S. C., 1411; removing sunken vessels or craft obstructing or endangering navigation, 1417.
EXAMINATIONS.—Water way from Pungo River to Sladesville, N. C., 1418; water way between Pamlico River and Bay River, N. C., 1421; Drum Inlet, N. C., 1425; harbor of Washington, Pamlico River, N. C., 1429; White Oak River, from Roberts Landing to Collins Crossing, N. C., 1434; Black River, from Kingstree to its mouth, S. C., 1435.

APPENDIX M.

REPORT OF CAPT. FREDERIC V. ABBOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Waccamaw River, N. C. and S, C., 1442; Lumber River, N. C. and S. C., 1445; Little Pedee River, S. C., 1448; Great Pedee River, S. C., 1450; Clark River, S. C., 1453; Mingo Creek, S. C., 1455; Santee River, S. C., 1458; Wateree River, S. C., 1462; Congaree River, S. C., 1464; harbor at Charleston, S. C., 1467; Ashley River, S. C., 1476; Wappoo Cut, S. C., 1477; Edisto River, S. C., 1480; Salkahatchie River, S. C., 1482; Beaufort River, S. C., 1485; removing sunken vessels or craft obstructing or endangering navigation, 1487.
EXAMINATION.—Wateree River, S. C., 1487.

PART III.

APPENDIX N.

REPORT OF CAPTAIN O. M. CARTER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Savannah River and Harbor, Ga., 1491; Savannah River, Ga., 1519; Darien Harbor, Ga., 1528; Altamaha River, Ga., 1531; Oconee River, Ga., 1536; Ocmulgee River, Ga., 1543; Brunswick Harbor, Ga., 1550; Jekyl Creek, Ga., 1556; Cumberland Sound, Ga., and Fla., 1559; removing sunken vessels or craft obstructing or endangering navigation, 1602.
EXAMINATION.—Yellow River, Ga., 1606.

APPENDIX O.

REPORT OF CAPT. W. M. BLACK, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Johns River, Fla., 1612; Ocklawaha River, Fla., 1620; Volusia Bar, Fla., 1627; St. Augustine Harbor, Fla., 1630; northwest entrance, Key West Harbor, Fla., 1640; Caloosahatchee River, Fla., 1643; channel of Charlotte Harbor and Pease Creek, Fla., 1646; Sarasota Bay, Fla., 1651; Manatee River, Fla., 1653; Tampa Bay, Fla., 1655; Withlacoochee River, Fla., 1659; harbor at Cedar Keys, Fla., 1661; Suwanee River, Fla., 1663.

Digitized by Google

EXAMINATIONS.—St. Johns River, Fla., from Jacksonville to Sanford, and the upper part of St. Johns River, from Lake Monroe southward, 1666; deep-sea channel at St. Augustine, Fla., 1671; Indian River, Fla., between Titusville and Jupiter Inlet, 1673; channel north and west of Cedar Keys, Fla., 1676; Pease River, Fla., 1678; Charlotte Harbor, Fla., 1681.
HARBOR LINES.—Establishment of harbor lines in St. Augustine Harbor, Fla., 1685.

APPENDIX P.

REPORT OF CAPT. PHILIP M. PRICE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Apalachicola Bay, Fla., 1694; Apalachicola River, Fla., including Lee Slough, 1696; Flint River, Ga., 1698; Chattahoochee River, Ga. and Ala., 1702; La Grange Bayou and Holmes River, Fla., 1704; Choctawhatchee River, Fla. and Ala., 1707; harbor at Pensacola, Fla., 1710; Escambia and Conecuh rivers, Fla. and Ala., 1735; Alabama River, Ala., 1738; Tallapoosa River, Ala., 1741; Coosa River, Ga. and Ala., 1743; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., 1753; Cahaba River, Ala., 1754.
EXAMINATIONS.—Chattahoochee River, Ga. and Ala., between West Point and Franklin, 1756; Alabama River, Ala., 1761.

APPENDIX Q.

REPORT OF MAJ. A. N. DAMRELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mobile Harbor, Ala., 1771; Warrior and Tombigbee rivers, Ala. and Miss., 1776; Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 1784; Noxubee River, Miss., 1787; Pascagoula River, Miss., 1788; Chickasahay River, Miss., 1791; Bluff Creek, Miss., 1792; Leaf River, Miss., 1792; harbor at Biloxi Bay, Miss., 1793; Pearl River, Miss., below Jackson, 1795; Pearl River, Miss., between Jackson and Carthage, 1797; Pearl River, Miss., between Edinburg and Carthage, 1799; Bogue Chitto, La., 1800.
EXAMINATION.—Sucarnochee River, Ala., 1800.

APPENDIX R.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

INSPECTION of the improvement of the South Pass of the Mississippi River, 1805.

APPENDIX S.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chefuncte River and Bogue Falia, La., 1818; Tickfaw River and its tributaries, La., 1819; Amite River and Bayou Manchac, La., 1820; Bayou La Fourche, La., 1821; Bayou Terrebonne, La., 1823; Bayou Plaquemine, La., 1824; Bayou Courtablean, La., 1826; Bayou Teche, La., 1828; mouth and passes of Calcasieu River, La., 1829; harbor at Sabine Pass, Tex., 1831; Sabine River, Tex., 1835; Neches River, Tex., 1836; removing sunken vessels or craft obstructing or endangering navigation, 1837.
EXAMINATIONS AND SURVEY.—Bayou Carlin, La., 1838; shoals on Lake Pontchartrain, La., near the Rigolets, 1839; Bayou Chevreuil and Bayou Tigre, La., 1841; Bayou Terre Bonne, La., from Houma to Thibodeaux, 1843; Bayou Black to connect with Terre Bonne, La., 1846; Berwick Bay, La., 1847; Bayou Cocodrie, La., 1849; Bayou Black, La., for connection between Calcasieu Lake and Sabine Lake, 1850; Bayou Teche, La., from Saint Martinsville to Port Barre, 1852; Bayou Des Glaises, La., 1854; Bayou Vermillion, La., 1855; Mermenton River and tributaries, La., 1858.

APPENDIX T.

REPORT OF LIEUT. JOHN MILLIS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Securing mouth of Bayou Plaquemine, La., from further caving, 1867; removing sunken vessels or craft obstructing or endangering navigation of New Orleans Harbor, La., 1869.

Digitized by Google

APPENDIX U.

REPORT OF MAJ. CHAS. J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Entrance to Galveston Harbor, Tex., 1871; ship channel in Galveston Bay, Tex., 1906; Trinity River, Tex., 1918; Cedar Bayou, Tex., 1922; Buffalo Bayou, Tex., 1924; harbor at Brazos Santiago, Tex., 1930.
EXAMINATIONS.—Mouth of Double Bayou, Chambers County, Tex., 1933; Trinity River, Tex., from its mouth to Dallas, 1936; Colorado River, Tex., 1939; Aransas Bay, Tex., to remove Half-Moon Reef; and St. Charles Bay, Tex., 1942.

PART IV.

APPENDIX V.

REPORT OF CAPT. J. H. WILLARD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Red River, La. and Ark., 1946; Red River above Fulton, Ark., 1961; Ouachita and Black rivers, Ark. and La., 1964; Ouachita River above Camden, Ark., 1975; Bayou D'Arbonne, La., 1980; Bayou Bartholomew, La. and Ark., 1982; Bayou Bœuf (Bœuf River), La., 1985; Tensas River and Bayou Maçon, La., 1989; Bayous Bondeway and Vidal, La., 1992; Big Black River, Miss., 1993; Yazoo River, Miss., 1996; Tchula Lake, Miss., 2001; Tallahatchee River, Miss., 2003; Steele Bayou and Washington Bayou, Miss., 2005; Big Sunflower River, Miss., 2007; Big Hatchee River, Tenn., 2010; Forked Deer River, Tenn., 2012; water gauges on Mississippi River and its principal tributaries, 2014; survey of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., 2021.
EXAMINATIONS.—Cane River, La., 2022; Bayou Castor, La., 2028.

APPENDIX W.

REPORT OF CAPT. H. S. TABER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing obstructions in Arkansas River, Ark., Ind. Ter., and Kans., 2033; Arkansas River, Ark., Ind. Ter., and Kans., 2037; Fourche Le Fevre River, Ark., 2044; Petit Jean River, Ark., 2046; White River, Ark., 2048; Cache River, Ark., 2051; Little Red River, Ark., 2053; Black River, Ark. and Mo., 2055; Black River, Mo., 2058; St. Francis River, Ark., 2059; St. Francis River, Mo., 2062; Little River, Mo. and Ark., 2064.
EXAMINATIONS.—Current River, from Van Buren, Mo., to its mouth, 2065.

APPENDIX X.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS.

EXAMINATION.—Mississippi River from high-water mark, Lake County, Tenn., to high-water mark, Fulton County, Ky., north and west of Reelfoot Lake, 2073.

APPENDIX Y.

REPORT OF MAJ. A. M. MILLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing snags and wrecks from Mississippi River, 2079; Mississippi River, between the Ohio and Illinois rivers, 2087; harbor at Saint Louis, Mo., 2109; Gasconade River, Mo., 2112; Osage River, Mo., 2114; Kaskaskia River, Ill., 2118.

APPENDIX Z.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

IMPROVEMENT.—Mississippi River, between Des Moines Rapids and mouth of Illinois River, 2119.
EXAMINATION.—Mississippi River at Warsaw, Ill., 2134.

Digitized by Google

APPENDIX A A.

REPORT OF MAJ. A. MACKENZIE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Operating snag boats and dredge boats on Upper Mississippi River, 2137; Mississippi River, between Minneapolis and Des Moines Rapids, 2147; Des Moines Rapids, Mississippi River, 2172; operating and care of Des Moines Rapids Canal and dry dock, 2174.
EXAMINATIONS AND SURVEY.—Slough at Hamilton, Ill., 2185; Mississippi River at and above Clinton, Iowa, 2187.

APPENDIX B B.

REPORT OF MAJ. W. A. JONES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mississippi River above Falls of St. Anthony, Minn., 2192; reservoirs at headwaters of Mississippi River, 2196; Chippewa River, including Yellow Banks, Wis., 2201; St. Croix River, Wis. and Minn., 2203; Minnesota River, Minn., 2207; Red River of the North. Minn. and N. Dak., 2210; surveys for reservoirs at the sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers 2214; gauging Mississippi River at or near St. Paul, Minn., 2214.
EXAMINATIONS.—Harbor at Hudson, Wis., 2218; Red River of the North at Goose Rapids, N. Dak. and Minn., 2220; Creel Bay, Totten Bay, and Minnewauken Shoals, in Devil Lake, N. Dak., 2223.

APPENDIX C C.

REPORT OF LIEUT. COL. CHAS. R. SUTER, CORPS OF ENGINEERS.

EXAMINATION.—Missouri River, from the old mouth of Platte River, Little Point, to a point opposite Leavenworth; and at Weston, Mo., 2229.

APPENDIX D D.

REPORT OF CAPT. CHAS. F. POWELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Missouri River between the Great Falls, Mont., and Sioux City, Iowa, 2232; Yellowstone River, Mont. and N. Dak., 2236.
EXAMINATIONS AND SURVEY.—Tongue River, Mont., 2237; Yellowstone River, Mont., 2239; Missouri River between Sioux City, Iowa, and Fort Benton, Mont., 2242.

APPENDIX E E.

REPORT OF LIEUT. COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, above Chattanooga, Tenn., and below Bee Tree Shoals, Ala., 2252; Hiawassee River, Tenn., 2259; French Broad River, Tenn., 2261; Clinch River, Tenn., 2264; Cumberland River, Tenn. and Ky., 2267; Caney Fork River, Tenn., 2284; South Fork of Cumberland River, Ky., 2286.
EXAMINATIONS AND SURVEY.—Little Pigeon River, Tenn., from mouth to Sevierville, 2287; harbor of Smithland, Ky., 2289; Obion River, Tenn., 2292.

APPENDIX F F.

REPORT OF LIEUT. GEO. W. GOETHALS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., 2303; operating and care of Muscle Shoals Canal, Tennessee River, 2322.
EXAMINATION.—Mouth of Gunter Creek at Guntersville, Ala., 2325.

Digitized by Google

APPENDIX G G.

REPORT OF LIEUT. COL. WM. E. MERRILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 2328; operating snag boats on Ohio River, 2349; operating and care of Davis Island Dam, Ohio River, 2350; movable dam in Ohio River near mouth of Beaver River, Pa., 2354; Monongahela River, W. Va. and Pa., 2355; operating and care of locks and dams Nos. 8 and 9, Monongahela River, 2357; purchase of Lock and Dam No. 7, Monongahela River, 2359; purchase of Lock and Dam No. 6, Monongahela River, 2360; Cheat River, W. Va., 2361; Allegheny River, Pa., 2363; dam at Herr Island, Allegheny River, 2366; ice-harbor at mouth of Muskingum River, Ohio, 2367; Muskingum River, Ohio, 2369; operating and care of locks and dams on Muskingum River, Ohio, 2369.
EXAMINATIONS.—Harbor of Owensboro, Ky., on the Ohio River, 2380; Tionesta Creek, Pa., 2381; Ohio River, between mouth of Green River, Ky., and Evansville, Ind., 2382.

APPENDIX H H.

REPORT OF MAJ. G. J. LYDECKER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River, at Louisville, Ky., 2387; Indiana Chute, Falls of the Ohio River, 2393; operating and care of Louisville and Portland Canal, Ky., 2394; Wabash River, Ind. and Ill., 2402; White River, Ind., 2409.
EXAMINATION.—Wabash River, Ind., from Terre Haute to La Fayette, 2411.

APPENDIX I I.

REPORT OF COL. WM. P. CRAIGHILL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Great Kanawha River, W. Va., 2413; operating and care of locks and dams on Great Kanawha River, W. Va., 2425; Elk River, W. Va., 2427; Gauley River, W. Va., 2428; New River, Va. and W. Va., 2430.
EXAMINATION.—Elk River, W. Va., 2433.

APPENDIX J J.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tradewater River, Ky., 2438; operating and keeping in repair locks and dams on Green and Barren rivers, Ky., 2439; Rough River, Ky., 2446; Kentucky River, Ky., 2449; operating and keeping in repair locks and dams on Kentucky River, Ky., 2455; Licking River, Ky., from Farmers to West Liberty, 2462; Big Sandy River, W. Va. and Ky., 2463; Levisa Fork of Big Sandy River, Ky., 2466; Tug Fork of Big Sandy River, W. Va. and Ky., 2467; Guyandotte River, W. Va., 2469; Little Kanawha River, W. Va., 2471; Buckhannon River, W. Va., 2474.
EXAMINATIONS.—Big Barren River, Ky., above Bowling Green, 2474; Russel Fork of the Big Sandy River, Ky., 2476; Green River, Ky., above mouth of Big Barren River, 2478.

APPENDIX K K.

REPORT OF CAPT. W. L. FISK, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Grand Marais, Minn., 2484; harbor at Agate Bay, Minn., 2486; harbor at Duluth, Minn., 2488; harbor at Superior Bay and St. Louis Bay, Wis., 2495; Minnesota Point at Superior, Wis., 2499; harbor at Ashland, Wis., 2500; harbor at Ontonagon, Mich., 2502; Eagle Harbor, Mich., 2505; harbor at Marquette, Mich., 2505; harbor of refuge at Grand Marais, Mich., 2509.
EXAMINATION.—Allouez Bay and Nemadji River, Wis., 2512.
HARBOR LINES.—Establishment of harbor lines at Duluth, Minn., bay of St. Louis, Superior Bay, and the adjacent waters, Minn. and Wis., 2515; establishment of harbor lines in Portage Lake, Mich., 2519; resurvey and relocation of harbor line in Portage Lake, Mich., 2522.

Digitized by Google

APPENDIX L L.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Manistique Harbor, Mich., 2523; Cedar River Harbor, Mich., 2525; Menomonee Harbor, Mich. and Wis., 2527; Menomonee River, Mich. and Wis., 2528; Oconto Harbor, Wis., 2531; Pensaukee Harbor, Wis., 2533; Green Bay Harbor, Wis., 2533; harbor of refuge at entrance of Sturgeon Bay Canal, Wis., 2536; Ahnapee Harbor, Wis., 2538; Kewaunee Harbor, Wis., 2540; Two Rivers Harbor, Wis., 2543; Manitowoc Harbor, Wis., 2545; Sheboygan Harbor, Wis., 2549; Port Washington Harbor, Wis., 2551; harbor of refuge at Milwaukee Bay, Wis., 2553; Milwaukee Harbor, Wis., 2560; Racine Harbor, Wis., 2562; Kenosha Harbor, Wis., 2565; Waukegan Harbor, Ill., 2568; Fox and Wisconsin rivers, Wis., 2572; operating and care of locks and dams on Fox River, Wis., 2580.

APPENDIX M M.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chicago Harbor, Ill., 2596; Calumet Harbor, Ill., 2602; Calumet River, Ill. and Ind., 2606; Illinois River, Ill., 2611; operating and care of La Grange Lock on Illinois River, Ill., 2630; Illinois and Mississippi Canal, 2633.
EXAMINATION AND SURVEY.—Illinois River, Ill., from La Salle to the Mississippi River, 2658.
HARBOR LINES.—Establishment of harbor lines in Chicago Harbor, Ill., 2661.

PART V.

APPENDIX N N.

REPORT OF MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—General remarks, 2667; Petoskey Harbor, Mich., 2670; Charlevoix Harbor and entrance to Pine Lake, Mich., 2672; Frankfort Harbor, Mich., 2674; harbor of refuge at Portage Lake, Mich., 2676; Manistee Harbor, Mich., 2678; Ludington Harbor, Mich., 2682; Pentwater Harbor, Mich., 2684; White River Harbor, Mich., 2687; Muskegon Harbor, Mich., 2689; Grand Haven Harbor, Mich., 2692; Holland [Black Lake] Harbor, Mich., 2696; Saugatuck Harbor, Mich., 2699; South Haven Harbor, Mich., 2700; St. Joseph Harbor, Mich., 2702; St. Joseph River, Mich., 2705; Michigan City Harbor, Ind., 2706.

APPENDIX O O.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Marys River, Mich., 2712; operating and care of St. Marys Falls Canal, Mich., 2724; dry dock at St. Marys Falls Canal, Mich., 2758; Hay Lake Channel, St. Marys River, Mich., 2758; harbor at Cheboygan, Mich., 2764; harbor at Thunder Bay, Mich., 2765; Thunder Bay River, Mich., 2768; harbor at Au Sable, Mich., 2771; Saginaw River, Mich., 2772; harbor of refuge at Sand Beach, Lake Huron, Mich., 2776; Black River at Port Huron, Mich., 2780; mouth of Black River, Mich., 2782; St. Clair Flats Canal, Mich., 2784; operating and care of St. Clair Flats Canal, Mich., 2787; Clinton River, Mich., 2788; Grosse Pointe Channel, Mich., 2790; Rouge River, Mich., 2791; Detroit River, Mich., 2793; removing sunken vessels or craft obstructing or endangering navigation, 2801.
EXAMINATIONS.—Sebewaing River, Mich., 2804; the American channel of the Detroit River, Mich., 2808; ship channel 20 feet in depth in the shallows of the connecting waters of the lakes between Chicago, Duluth, and Buffalo, 2810; Corsica Shoal, Mich., at lower end of Lake Huron, 2820; Rouge River, Mich., 2822.

APPENDIX P P.

REPORT OF MAJ. L. COOPER OVERMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 2825; Toledo Harbor, Ohio, 2828; Port Clinton Harbor, Ohio, 2835; Sandusky City Harbor, Ohio, 2837; Sandusky River, Ohio, 2840; Huron Harbor, Ohio, 2843; Vermillion Harbor, Ohio, 2847; Black River Harbor, Ohio; 2849; Cleveland Harbor, Ohio, 2853; Fairport Harbor, Ohio, 2859; Ashtabula Harbor, Ohio, 2863.

Digitized by Google

APPENDIX Q Q.

REPORT OF MAJ. AMOS STICKNEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 2869; preservation and protection of Presque Isle Peninsula, Erie Harbor, Pa., 2877; Dunkirk Harbor, N. Y., 2878; Buffalo Harbor, N. Y., 2882; Tonawanda Harbor and Niagara River, N. Y., 2888; Wilson Harbor, N. Y., 2891; Olcott Harbor, N. Y., 2893; Oak Orchard Harbor, N. Y., 2896.

APPENDIX R R.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Charlotte, N. Y., 2899; harbor at Pultneyville, N. Y., 2903; harbor at Great Sodus Bay, N. Y., 2906; harbor at Little Sodus Bay, N. Y., 2909; harbor at Oswego, N. Y., 2912; harbor at Sacketts Harbor, N. Y., 2918.

APPENDIX S S.

REPORT OF MAJ. M. B. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Shoal between Sister Islands and Cross-over Light, St. Lawrence River, N. Y., 2922; Ogdensburg Harbor, N. Y., 2923; Grass River, N. Y., 2926; breakwater at Rouse Point, Lake Champlain, N. Y., 2927; Great Chazy River, N. Y., 2929; breakwater at Gordon Landing, Lake Champlain, Vt., 2930; Plattsburg Harbor, N. Y., 2931; Burlington Harbor, Vt., 2932; Otter Creek, Vt., 2935; Ticonderoga River, N. Y., 2936; Narrows of Lake Champlain, N. Y. and Vt., 2937.
EXAMINATIONS.—Inner Bay, near mouth of Saranac River, at Plattsburg, N. Y., 2938; Boquet River, N. Y., from mouth on Lake Champlain to Willsboro, 2940.

APPENDIX T T.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Oakland Harbor, Cal., 2943; survey of San Francisco Harbor, San Pablo and Suisun bays, strait of Karquines, and mouths of San Joaquin and Sacramento rivers, Cal., 2947.
HARBOR LINES.—Modification of harbor lines on Port Costa front, south shore of Karquines Strait, San Francisco Harbor, Cal., 2948.

APPENDIX U U.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Napa River, Cal., 2952; Redwood Harbor, Cal., 2953; Redwood Creek, Cal., 2953; San Luis Obispo Harbor, Cal., 2955; Wilmington Harbor, Cal., 2956; San Diego Harbor, Cal., 2960.
EXAMINATIONS.—San Rafael River, Cal., 2963; Alviso Harbor and Alviso Creek, Cal., 2964; Redwood Creek, Cal., 2966; harbor of refuge at Santa Cruz, Cal., 2968; San Simeon Bay, Cal., 2971; Redondo Beach Harbor, Cal., 2972; Colorado River, Ariz., above Yuma, to Eldorado Canyon, 2974.
HARBOR LINES.—Establishment of harbor lines at San Pedro, Wilmington Harbor, Cal., 2976.

APPENDIX V V.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—San Joaquin River, Cal., 2981; Mokelumne River, Cal., 2986; Sacramento and Feather rivers, Cal., 2987; investigation of mining-débris question in State of California, 2996; Petaluma Creek, Cal., 3119; Humboldt Harbor and Bay, Cal., 3120.
EXAMINATION AND SURVEY.—Mokelumne River, Cal., 3133.
HARBOR LINES.—Establishment of harbor lines in Humboldt Bay, Cal., 3138.

Digitized by Google

APPENDIX W W.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Coquille River, Oregon, 3146; entrance to Coos Bay, Oregon, 3154; Umpqua River, Oregon, 3169; mouth of Siuslaw River, Oregon, 3173; entrance to Yaquina Bay, Oregon, 3182; Tillamook Bay and Bar, Oregon, 3200; entrance to harbor at Nehalem Bay, Oregon, 3205; Upper Columbia and Snake rivers, Oregon and Wash., 3210; Columbia River between head of Rock Island Rapids and foot of Priest Rapids, Wash., 3223; Chehalis River, Wash., 3236; Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Wash., 3238.

EXAMINATIONS AND SURVEYS.—Alsea Bay and River, Oregon, 3246; Clark Fork of Columbia River from international boundary line to mouth of Big Blackfoot River, Mont., 3250; Puyallup River, Wash., 3255; D'Wamish and Black Rivers, Wash., 3257; ship channel between Port Townsend Bay, Puget Sound, and Oak Bay, Wash., 3260; North River, Wash., 3263; Shoalwater Bay and Willapah River, Wash., 3266; Nooksack, Skagit, and Snohomish rivers, Wash., 3271; Coquille River, Oregon, from Coquille City to Myrtle Point, 3275; Coos Bay, Oregon, 3283; Upper Snake River, Idaho, 3285; Nasel River, Wash., 3294; Grays Harbor and Bar and Chehalis River up to Montesano, Wash., 3297; Port Orford Harbor, Oregon, 3305.

APPENDIX X X.

REPORT OF MAJ. THOS. H. HANDBURY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mouth of Columbia River, Oregon and Wash., 3314; canal at the Cascades, Columbia River, Oregon, 3328; Columbia and Lower Willamette rivers below Portland, Oregon, 3362; Willamette River above Portland, Oregon, 3368; Cowlitz River, Wash., 3370; Youngs and Klaskuine rivers, Oregon, 3371; gauging waters of Columbia River, Oregon and Wash., 3372; removing sunken vessels or craft obstructing or endangering navigation, 3373.

EXAMINATIONS AND SURVEYS.—Willamette River, channel on west side of Swan Island, Oregon, 3373; Youngs Bay Channel, Oregon, 3376; Deep, Skamokawa, and Crooked rivers, Wash., 3378; Lower Columbia River, between Astoria and Woods Landing, Oregon, 3380: Yamhill River, Oregon, 3381; Lewis and Clarke River, Oregon, 3383; Grays River, Wash., 3385.

HARBOR LINES.—Establishment of harbor lines in Astoria Harbor, Oregon, 3387.

APPENDIX Y Y.

REPORT OF CAPT. W. A. KIRKLAND, UNITED STATES NAVY.

SUPERVISION of the harbor of New York, 3393.

PART VI.

APPENDIX Z Z.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

C. B. COMSTOCK, Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A., President; CHARLES R. SUTER, Lieutenant-Colonel, Corps of Engineers, U. S. A.; O. H. ERNST, Major, Corps of Engineers, Colonel, U. S. A.; HENRY L. WHITING, Assistant U. S. Coast and Geodetic Survey; B. M. HARROD, ROBERT S. TAYLOR, and HENRY FLAD, *Commissioners*.

ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1891, 3397.

APPENDIX A.—Report of Lieut. Col. Charles R. Suter, Corps of Engineers, upon investigation of discharge measurements, Mississippi River, 3417.

APPENDIX B.—Paper by Lieut. Col. Charles R. Suter, Corps of Engineers, on effects of crevasses upon gauge readings below Red River during high water of 1890, 3444.

Digitized by Google

APPENDIX C.—Report of the secretary of the Commission, 3446; (1) paper by Capt. Charles F. Powell, Corps of Engineers, on depression of the flood line, 1890, below Red River, from crevasses, 3463; (2) paper by Capt. Charles F. Powell, Corps of Engineers, on effects of outlets on the bed of the river below them, 3465; (3) instructions for secondary triangulation, precise level, and topographical and hydrographical field work, 3474; (4) report of Mr. J. A. Ockerson, assistant engineer, on profile of Mississippi River, Cairo to Donaldsonville, 3486; (5) tabulated results of discharge measurements on Mississippi, Old, and Atchafalaya rivers, 1887–1889, 3487; (6) tabulated results of discharge measurements on Mississippi and Atchafalaya rivers and Bayou La Fourche, 1890, 3526; (7) high-water marks of 1890, Mississippi River, Cairo, Ill., to Carrollton, La., 3547; (8) high-water marks of 1891, Mississippi River, Cairo, Ill., to Carrollton, La., 3551; (9) high and low waters, referred to present or most recent gauges, of Mississippi River and principal tributaries except the Missouri, 3555; (10) report of Mr. J. A. Ockerson, assistant engineer, on changes in the bed of Mississippi River near the head of the Passes, 3575; commercial statistics, 3576.

APPENDIX D.—Report of Capt. S. W. Roessler, Corps of Engineers, on operations in the first and second districts, 3580; (1) report of Mr. Aug. J. Nolty, assistant engineer, on work at Plum Point Reach, 3595; (2) paper by Mr. Aug. J. Nolty, assistant engineer, on details of construction of bank protection at Plum Point Reach, 1890, 3601; (3) paper by Mr. Aug. J. Nolty, assistant engineer, on details of construction of pile dikes at Plum Point Reach, 1890, 3606; (4) report of Mr. W. M. Rees, assistant engineer, on proposed system of levees along St. Francis Front, 3610; (5) report of Mr. W. M. Rees, assistant engineer, on levee survey, White River Front, 3612; financial statements, commercial statistics, etc, 3619.

APPENDIX E.—Report of Capt. C. McD. Townsend, Corps of Engineers, on operations in the third district, 3627; (1) report of Mr. Wm. P. Richards, surveyor, on surveys and observations, third district, 3658; (2) report of Mr. John J. Hoopes, assistant engineer, on discharge observations at Arkansas City, 3660; (3) estimate of Mr. Henry B. Richardson, chief engineer, State of Louisiana, for levee construction in Louisiana from State line to Warrenton, 3662; (4) report of Capt. Wm. T. Rossell, Corps of Engineers, on connection between Arkansas River levees and Mississippi River levees, 3663.

APPENDIX F.—Report of Lieut. John Millis, Corps of Engineers, on operations in the fourth district, 3665; (1) report of Lieut. John Millis, Corps of Engineers, on survey of Mississippi River, near Natchez, Miss., and Vidalia, La., 3716.

APPENDIX A A A.

REPORT OF THE MISSOURI RIVER COMMISSION.

CHAS. R. SUTER, Lieutenant-Colonel, Corps of Engineers, U. S. A., President; A. MACKENZIE, Major, Corps of Engineers, U. S. A.; O. H. ERNST, Major, Corps of Engineers, Colonel, U. S. A.; GARLAND C. BROADHEAD and RICHARD S. BERLIN, *Commissioners.*

ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1891, 3723.

APPENDIX A.—Annual report of Secretary, Missouri River Commission, 1891, 3733; (1) report on the commerce on Missouri River during year 1891, 3737; (2) annual report of Mr. G. A. Marr, assistant engineer, 1891, 3745; (3) annual report of Mr. O. B. Wheeler, assistant engineer, 1891, 3756; (4) tables of results of secondary triangulation of Missouri River, 3760; (5) report of Mr. Chas. F. Potter, division engineer, on shore-line surveys, 3802; (6) report of Mr. S. Waters Fox, division engineer, on shore-line surveys, 3804; (7) report of Mr. Samuel H. Yonge, division engineer, on shore-line surveys, 3805; (8) annual report of Mr. D. W. Wellman, assistant engineer, 1891, 3807; (9) annual report of Mr. A. H. Blaisdell, assistant engineer, 1891, 3819; (10) annual report of Mr. James A. Seddon, assistant engineer, 1891, 3827.

APPENDIX B.—Annual report of Lieut. Hiram M. Chittenden, Corps of Engineers, 1891, 3831.

APPENDIX C and C 1.—Annual reports of Mr. Chas. F. Potter, division engineer, 1891, 3832.

APPENDIX D.—Annual report of Mr. S. Waters Fox, division engineer, 1891, 3835.

APPENDIX E.—Annual report of Mr. Samuel H. Yonge, division engineer, 1891, 3848.

APPENDIX B B B.

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

REPORT of The Board of Engineers on proposed bridge across Hudson River at New York City, 3853; report of Board of Engineers on bridge across Chicago River at Canal street, Chicago, Ill., 3861.

Digitized by Google

APPENDIX C C C.

OCCUPANCY OF AND INJURY TO PUBLIC WORKS BY CORPORATIONS AND INDIVIDUALS.

(1) REPORT of Lieut. Col. G. L. Gillespie, Corps of Engineers, 3865; (2) report of Col. Wm. P. Craighill, Corps of Engineers, 3866; (3) report of Capt. H. S. Taber, Corps of Engineers, 3867; (4) report of Col. O. M. Poe, Corps of Engineers, 3868; (5) report of Maj. Amos Stickney, Corps of Engineers, 3872; (6) report of Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, 3873.

APPENDIX D D D.

REPORT OF LIEUT. COL. GEORGE H. ELLIOT, CORPS OF ENGINEERS.

WASHINGTON AQUEDUCT, 3875; water supply, District of Columbia, 3897; increasing the water supply of Washington, D. C., 3904; erection of fishways at Great Falls, 3905.

APPENDIX E E E.

REPORT OF COL. O. H. ERNST, UNITED STATES ARMY.

IMPROVEMENT and care of public buildings and grounds in the District of Columbia, Washington Monument, 3907.

APPENDIX F F F.

SURVEY OF THE NORTHERN AND NORTHWESTERN LAKES.

RESURVEY of Marquette Harbor, Michigan, 3927; issue of published charts of the northern and northwestern lakes, 3927.

APPENDIX G G G.

REPORT OF MAJ. WILLIAM A. JONES, CORPS OF ENGINEERS.

CONSTRUCTION and improvement of roads and bridges in the Yellowstone National Park, 3931.

APPENDIX H H H.

EXPLORATIONS AND SURVEYS IN DIVISIONS AND DEPARTMENTS.

REPORT of Capt. W. L. Marshall, Corps of Engineers, Engineer Officer, on operations in Division of the Missouri, 3943; report of Capt. Charles H. Clark, Ordnance Department, Acting Engineer Officer, on operations in Department of the Columbia, 3945; report of Lieut. Charles A. Worden, Seventh Infantry, Acting Engineer Officer, on operations in Department of the Platte, 3946; report of Lieut. James E. Runcie, First Artillery, Acting Engineer Officer, on operations in Division of the Pacific, 3947.

Digitized by Google

Digitized by Google

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

Digitized by Google

Digitized by Google

APPENDIX N.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN GEORGIA, AND OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

REPORT OF CAPTAIN O. M. CARTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Savannah River and Harbor, Georgia.
2. Savannah River, Georgia.
3. Darien Harbor, Georgia.
4. Altamaha River, Georgia.
5. Oconee River, Georgia.
6. Ocmulgee River, Georgia.
7. Brunswick Harbor, Georgia.
8. Jekyl Creek, Georgia.
9. Cumberland Sound, Georgia and Florida.
10. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

11. Yellow River, Georgia, from the Railroad Bridge near Covington to the Ocmulgee with a view of obtaining a steamboat channel of 5 feet deep at mean low water.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., July 8, 1891.

GENERAL: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1891, upon the works of river and harbor improvements then in my charge.

Very respectfully, your obedient servant,

O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

N 1.

IMPROVEMENT OF SAVANNAH RIVER AND HARBOR, GEORGIA.

Operations for improving this harbor and river have been carried on during the last fiscal year in accordance with a project of improvement approved by the Secretary of War July 22, 1890, and printed as part of

Digitized by Google

Appendix O 1, Annual Report of the Chief of Engineers for 1890. For a special history of past work, see pages 1012–1023, Annual Report of the Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

In 1873, before the work of improvement was inaugurated, the usual draft of vessels navigating the river at high water was 14.5 feet. The mean rise and fall of the tide was about 6.5 feet at the city of Savannah, and 7 feet at the mouth of the river.

PLAN OF IMPROVEMENT.

The plan of improvement under which operations have been carried on during the last fiscal year provides for the establishment of a channel depth of 26 feet at mean high water from the city of Savannah to the sea. The mean rise and fall of tides varies from 6.97 feet at Fort Pulaski to 6.07 feet at the barge office in the city of Savannah. The principal features of the project of improvement, which is printed as a part of Appendix O 1, Annual Report of the Chief of Engineers for 1890, are:

(1) The enlargement of Drakie Cut.
(2) The entire or partial removal of King Island.
(3) The construction of a deflecting jetty from Argyle Island.
(4) The partial removal of Marsh Island and the closing of the channel north of it.
(5) The construction of a training wall from Marsh Island to Kinsey Point and the enlargement of the river near there.
(6) The construction of a training wall at Garden Bank.
(7) Spur jetties or bank protection in the Wrecks Channel, and a deflecting jetty at Mackay Point.
(8) The removal of a portion of Dam No. 15.
(9) The closing of Duck Puddle.
(10) The construction of shore protection and of training walls between the wing dams in North Channel from the Upper Flats to the Oyster Bed.
(11) The construction of training walls extending eastward from Cockspur Island and the Oyster Bed.
(12) Dredging is provided for between the Cross Tides and Tybee Roads.

The estimated cost of this improvement is $3,500,000, providing funds are regularly and adequately supplied.

Prior to 1826 an expenditure of about $100,000, raised by a tax upon shipping entering the harbor, was made under the direction of the commissioners of pilotage in clearing the river of wrecks, and in otherwise improving its condition, and between 1867 and 1871 an expenditure of $157,000 was made by the city of Savannah in dredging on the shoals between Cross Tides and the sea. From 1826, the date of the first appropriation made by the United States for the river, up to the date of beginning operations according to the 26-foot plan of improvement, appropriations aggregating $1,879,096.64 were made by Congress for the work.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

In 1872 the United States Engineer Department resumed charge of the improvement of the river and harbor, and from that time up to

Digitized by Google

July 1, 1874, (since which date operations have been carried on in accordance with the 22-foot plan of improvement described on p. 1246, Annual Report of the Chief of Engineers for 1890), there were removed from the channel 6 vessels, 16 cribs, and 1 sunken lighter, besides 166,498 cubic yards of material, dredged from the wrecks, the shoals abreast of Elba Island and at the Oyster Beds, and from Tybee Knoll.

Under the 22-foot project the following work has been accomplished:

At Cross Tides a dam has been constructed, extending from the rice dike on Argyle Island to that on Hutchinson Island, with the object of diverting a larger volume of water at ebb tide into the Front River. This dam was originally designed to be a pile structure, and was begun in 1876. During the next year it was so much injured by a freshet that work upon it was suspended. In December, 1878, the present dam was begun. It is composed of log and brush mattresses, and brush fascines loaded with riprap stone, and is located 273 feet above the abandoned pile structure.

As soon as the dam was brought up above the level of mean low water considerable settlement occurred, due to scour caused by the ebb-tide overpour. To prevent further scour an apron of log mattresses was placed along its downstream face, and the dam was raised in 1885 with brush fascines and stone to the level of high water by building on the up-stream side of the crest, utilizing the old structure as an additional apron.

Since that time further settlement has occurred, and the work has also been damaged by fishermen and other parties who throw large quantities of stone off the dam to open a short water route from Back River to the city of Savannah.

About 70 linear feet of the old King's Island Jetty, near Cross Tides, was removed in 1880–'81 to facilitate the flow of water into Front River.

Three wing dams were constructed in 1882–'83 for the improvement of the Garden Bank Shoal in front of the city. They spring from Fig Island and contract the water way which was formerly from 900 to 1,050 feet in width to about 560 feet. A short spur jetty was built in 1883 about 800 feet above the lower end of Fig Island to regulate the ebb flow from Front River into the Wrecks Channel.

To properly confine the ebb currents in the Wrecks Channel a training wall rising to mean high water was built for a length of about 6,750 feet down stream from a point a little above the lower end of Fig Island with which it is connected by a return work 160 feet in length.

This training wall, begun in 1881, and extended and raised at inter vals since then, runs about parellel to the right bank of the river and is provided on the channel side with 11 short spurs placed at right angles to the axis of the channel, which has a low-water width increasing from 680 feet at the upper end to 880 feet at the lower.

Two dams, numbered 5 and 11½, respectively, and designed to increase the flow of water in the main channel were built in 1883 to close lateral channels on either side of Barnwell Island, opposite Fort Oglethorpe.

A low-sill dam, designed to increase the ebb flow in the north channel, was built in 1881 across the south channel a short distance below the head of Elba Island.

A wing dam, numbered 15, was built in 1883 for the improvement of the channel at the Obstructions. It extends eastward from Barnwell Island, No. 3, and contracts the water way, which was formerly about 1,950 feet in width, to about 1,000 feet.

Digitized by Google

Three pairs of wing dams have been built for the improvement of the crossing at the Upper Flats. Those numbered 4 and 23, built in 1883, constitute the upper pair and are situated at the eastern end of Spirit Island. Those numbered 6 and 25, constituting the second pair, and those numbered 10 and 27, constituting the third pair, are situated at distances below the first of about 800 and 1,600 yards, respectively.

The original low-water width of the river at this crossing varied from 2,000 to 4,000 feet. It is reduced by these dams to 1,050 feet at the upper and to 1,200 feet at the lower pair. These dams rest, with the inner ends of the respective pairs, upon opposite banks of the river, with the exception of the one numbered 27, between whose inner end and the shore there is a gap of about 500 yards.

Three wing dams have been built for the improvement of the crossing at the Lower Flats. At the upper end of this crossing, dams numbered 14 and 29 were built in 1883–'85. They spring from the opposite banks of the river, and contract the water way from over 2,400 feet to 1,250 feet. At the lower end of this crossing a partially-completed dam, numbered 13, was built in 1883. It springs from Islands 1 and 2, and leaves a water way 1,250 feet in width between its outer end and the opposite shore of Jones Island.

The lateral channels at Philbrick's Cut, Big Gap, and Dutch Gap are closed by dams built in 1882.

Two pairs of wing dams have been built for the improvement of the Long Island Crossing.

Dams numbered 26 and 33, constituting the upper pair, were built in 1885. They reduce the low-water width of the river from 3,100 to 1,300 feet. Dams numbered 28 and 35, constituting the lower pair, were built in 1886–'87, and reduce that width from 4,500 to 1,350 feet. The inner ends of these dams are connected with the shore, with the exception of number 35, between whose inner end and the shore of Jones Island there is a gap of 500 feet.

To prevent the diversion of the ebb flow from the main ship channel a dam numbered 31, and about 3,500 feet in length, was built in 1885, to close the old channel north of the Oyster Beds.

For the improvement of the channel across Tybee Knoll, a training wall, extending from the Oyster Beds eastward a distance of 10,031 feet, was begun in January, 1889. Two courses were completed during that fiscal year, and during next year the third course was extended 3,660.6 feet, and an additional load of riprap was placed on the entire crest.

All of the structures described are composed of log and brush mattresses, or brush fascines, or both, loaded with riprap stone. In their original construction and the repairs which it has been necessary to execute up to July 1, 1890, there have been used 438,679.49 square yards of log and brush mattresses, 165,853.28 cubic yards of brush fascines, 95,353.58 cubic yards of riprap stone, and 1,591.87 cubic yards of shells, while 973 cubic yards of stone have been removed in repairing the Fig Island training wall.

During this period the river channel was widened at the lower end of Fig Island, and more or less dredging was done upon the various shoals between Cross Tides and Tybee Knoll. Up to July 1, 1890, the total dredged material removed, consisting of sand, mud, and shells, amounted to 2,076,857.52 cubic yards.

Up to July 1, 1890, the total expenditures on Savannah Harbor by the United States since 1826, including outstanding liabilities, amounted to $1,875,219.03.

Digitized by Google

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

When the appropriation made by the act of September 19, 1890, became available, a project for its expenditure was submitted and approved. Proposals for dredging were opened on September 15, 1890. P. Sanford Ross was the lowest bidder, and a contract for the work was entered into with him on November 11, 1890.

Proposals for stone, mattress, and pile work were opened on October 20, 1890, and a contract was entered into on November 5, 1890, with Mr. John F. Gaynor, he being the lowest bidder.

Jetty work was begun on November 20, 1890. The oyster-bed training wall was extended 1,984.1 feet, making its total length 12,016.1 feet. There were placed 1,984.1 linear feet of log and brush mattresses in the foundation course; 2,380.9 linear feet in the second course; 3,379.8 linear feet in the third course; 6,994.9 linear feet in the fourth course, and 481.9 linear feet in the fifth course. In addition to the stone used in sinking the mattresses, the crest of the training wall was heavily loaded with riprap stone, being brought up to mean low water for a distance of 7,000 feet. There were used 72,178.4 square yards of log and brush mattresses and 26,160.5 cubic yards of riprap stone.

For the protection of caving banks there were built in April, May, and June, at Elba Island 17 spur dams of piles and brush, aggregating 1,248.2 feet in length, and at Jones Island, 27 similar dams aggregating 2,845.8 feet in length. There were used in these dams 1,131 piles, 12,114.17 cubic yards of brush fascines, and 315.93 cubic yards of stone. In the closing dam at Duck Puddle, 532 feet in length, there were used 275 piles, 6,218.99 cubic yards of brush fascines, and 778.39 cubic yards of stone.

In the southern Elba Island training wall there were used up to the close of the year 933 piles, 7,492.41 cubic yards of brush, and 40 cubic yards of stone.

Dredging was begun November 5, and is still in progress. During the year there were removed 59,998.85 cubic yards from the channel near the Ocean Steamship wharves; 26,324.2 cubic yards from the Garden Bank; 54,781.9 cubic yards from the upper and 137,079.4 cubic yards from the lower end of Wrecks Channel; 55,396.8 cubic yards from the Upper Flats, and 62,563.51 cubic yards from Tybee Knoll, an aggregate of 396,144.66 cubic yards.

Miscellaneous office work has been carried on during the year.

CONDITION OF WORK JUNE 30, 1891.

Cross Tides.—The condition of this dam is about as described in my report for 1888. The general crest is now at an average height of 1.5 feet above mean low water.

City of Savannah.—The depth of water between the Ocean Steamship wharves and the city waterworks has not changed during the year. From January to April a cut varying in width from 120 to 180 feet was made through the shoal near the upper rice mill; the entire length of channel thus improved being about 3,400 feet. There is now a navigable channel across this shoal not less than 18 feet deep at mean low water, an increase of 3 feet in depth since the beginning of the present fiscal year. During April and May a cut 60 feet wide and about 400 feet long was dredged through the shoal at Garden Bank. The cut is still in good order, there being a minimum channel depth of 15.5 feet at mean low water; a gain of about half a foot during the year. The Garden Bank wing dams are in good condition.

Digitized by Google

Wrecks Channel.—There is a gap about 5 feet deep and 100 feet long near the lower end of the Fig Island training wall. With this exception the work is in good condition and shows no settlement. From January to May a cut varying in width from 150 to 210 feet and 2,800 feet in length was made near the upper mouth of Wrecks Channel, and from December to May a cut from 80 to 280 feet in width and 2,500 feet in length was made near the lower mouth of the same channel. These cuts have held well, the minimum channel depth being 17 feet at mean low water; a gain of 2 feet since my last report.

Obstructions.—Wing Dam 15 is in good condition, but the head of Elba Island, opposite, is cutting badly. No work was done at this point during the year, but the channel has widened and deepened by natural scour, there being now a minimum channel depth of 16 feet at mean low water; a gain of half a foot since my last report.

Upper Flats.—All of the wing dams and the training wall built for the improvement of this crossing are in good condition. No dredging was done on the upper portion of these flats, but the channel there has somewhat improved by natural scour since the closing of the Duck Puddle. From November to January a cut 195 feet in width and 2,100 feet in length was dredged through the shoal at the lower end of the flats. There is now at mean low water a least channel depth of 18.5 feet at the lower and of 15.5 feet at the upper end of these flats.

Lower Flats.—All of the wing dams in this locality are in good condition. No dredging was done during the year, but the channel has deepened and widened by natural scour, there being now a navigable channel across these flats not less than 15 feet deep at mean low water; a gain of 1 foot since my last report.

Long Island Crossing.—The wing dams at this crossing are in good condition. No dredging has been done here, but the channel has improved by natural scour. While the area of the 15-foot channel remains practically the same as in 1890, that of the 18-foot channel, which was then inconsiderable, now extends almost over the entire length of the crossing, leaving only a gap of about 700 feet in length at the lower end. The minimum mean low-water channel depth now found on this crossing is 17 feet against 16 feet in 1890.

Oyster beds.—Dam 31 is in good condition. The channel at that point has been well maintained during the year.

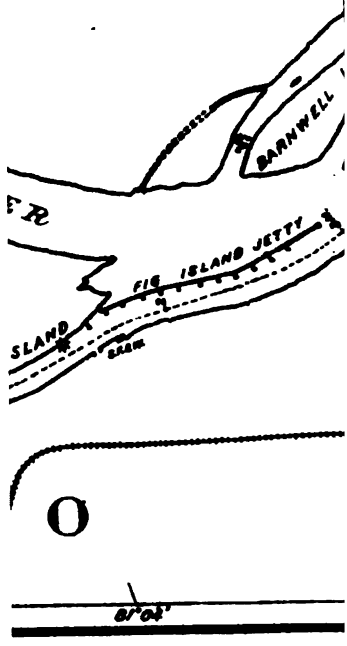
Tybee Knoll.—The oyster-bed training wall is in good condition. During May and June a cut 45 feet in width and 5,072 feet in length had been made through the upper part of the knoll, and dredging was still in progress at the end of the fiscal year. No dredging has yet been done at the lower end of the knoll, but the channel has improved by natural scour along almost its entire length down to the bell buoy. The minimum channel depth is 14 feet about the same as at the close of the last fiscal year.

Shore protection.—Some of the spur dams built at Elba and Jones Islands for the protection of the caving banks have been slightly injured by passing vessels. They have, however, been very successful, all erosion having been arrested, and the spaces between their heads are rapidly filling up with silt.

Closing dams.—All of the closing dams upon the river, with the exception of those at Philbrick Cut and Big Gap, are in good condition. Some breaks have taken place in the closing dams at Philbrick Cut and Big Gap, which when completed were at the level of mean high water. A great deal of stone has been thrown off of those dams by negro fishermen to open a water way through into the South Channel,

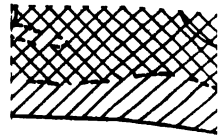
Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google



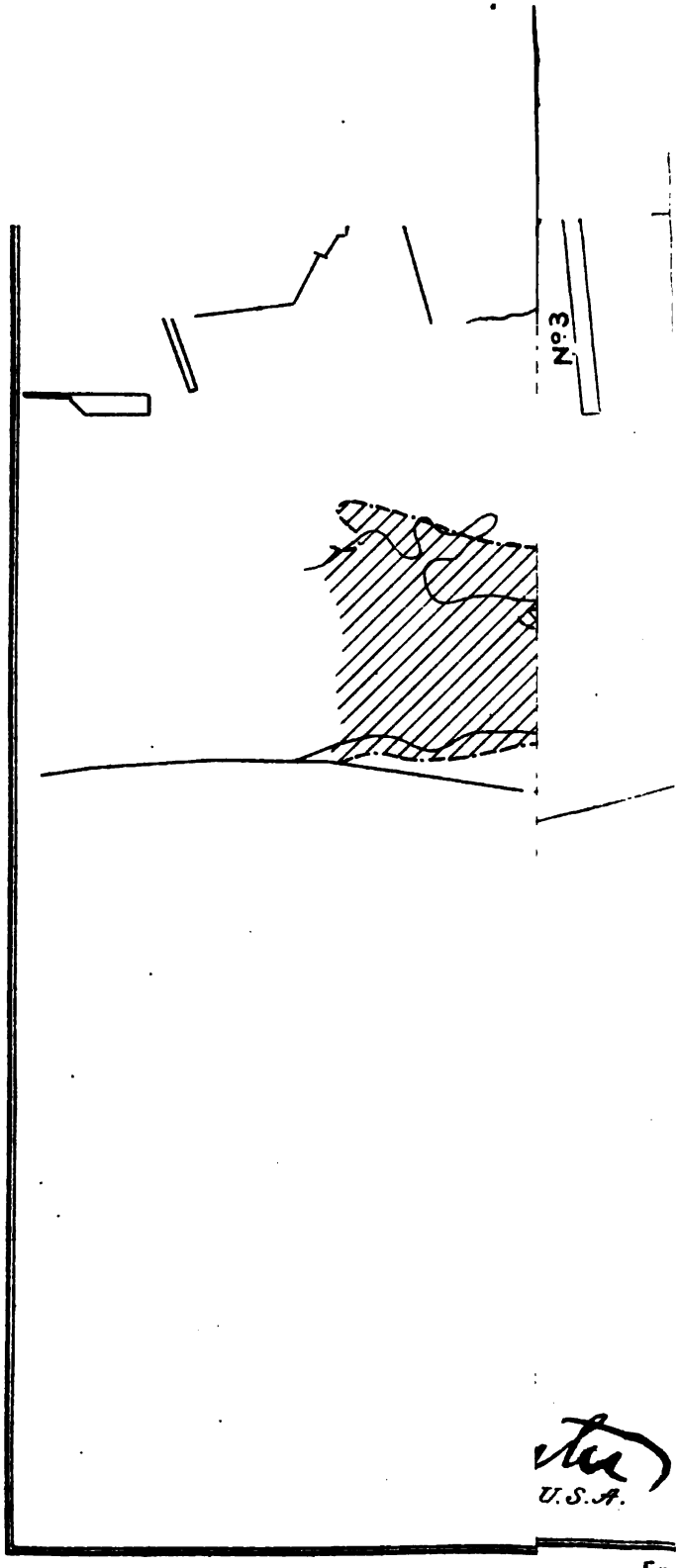
ARF

U. S. Engine
Savannah
accompa

Digitized by Google

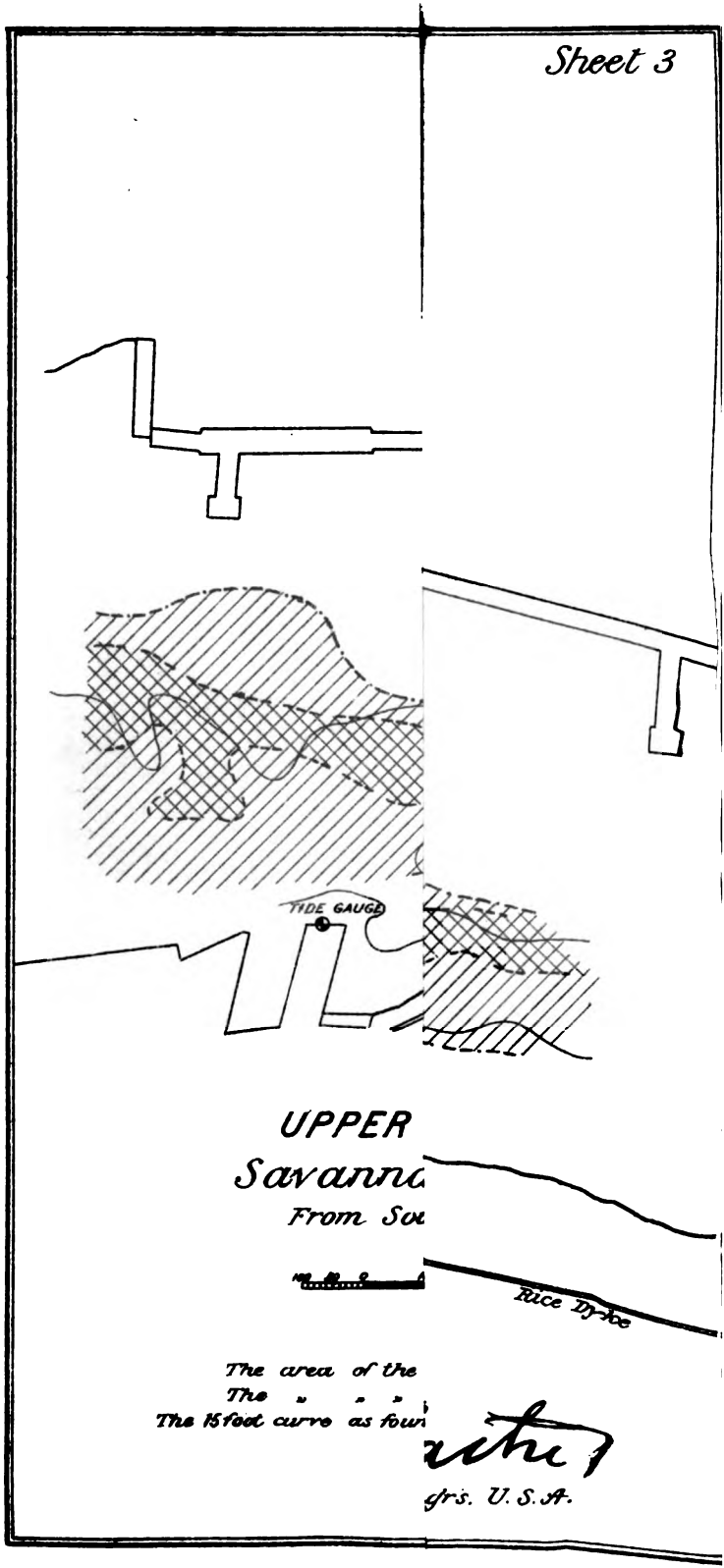
Digitized by Google

3



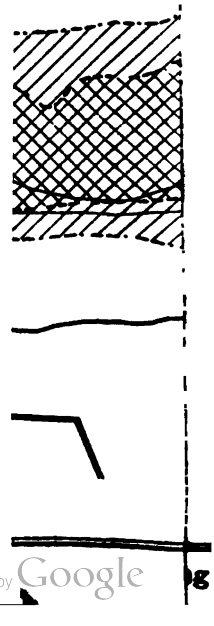
Digitized by Google

Digitized by Google



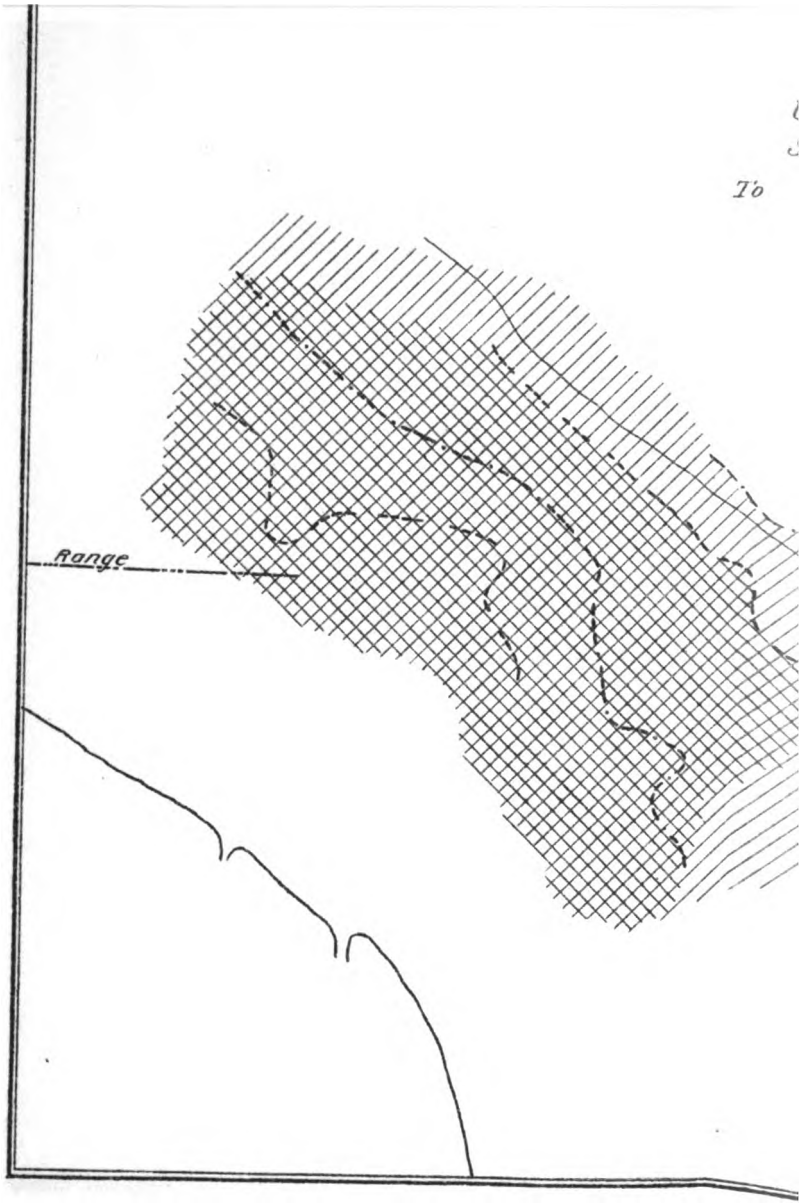
Digitized by Google

Digitized by Google



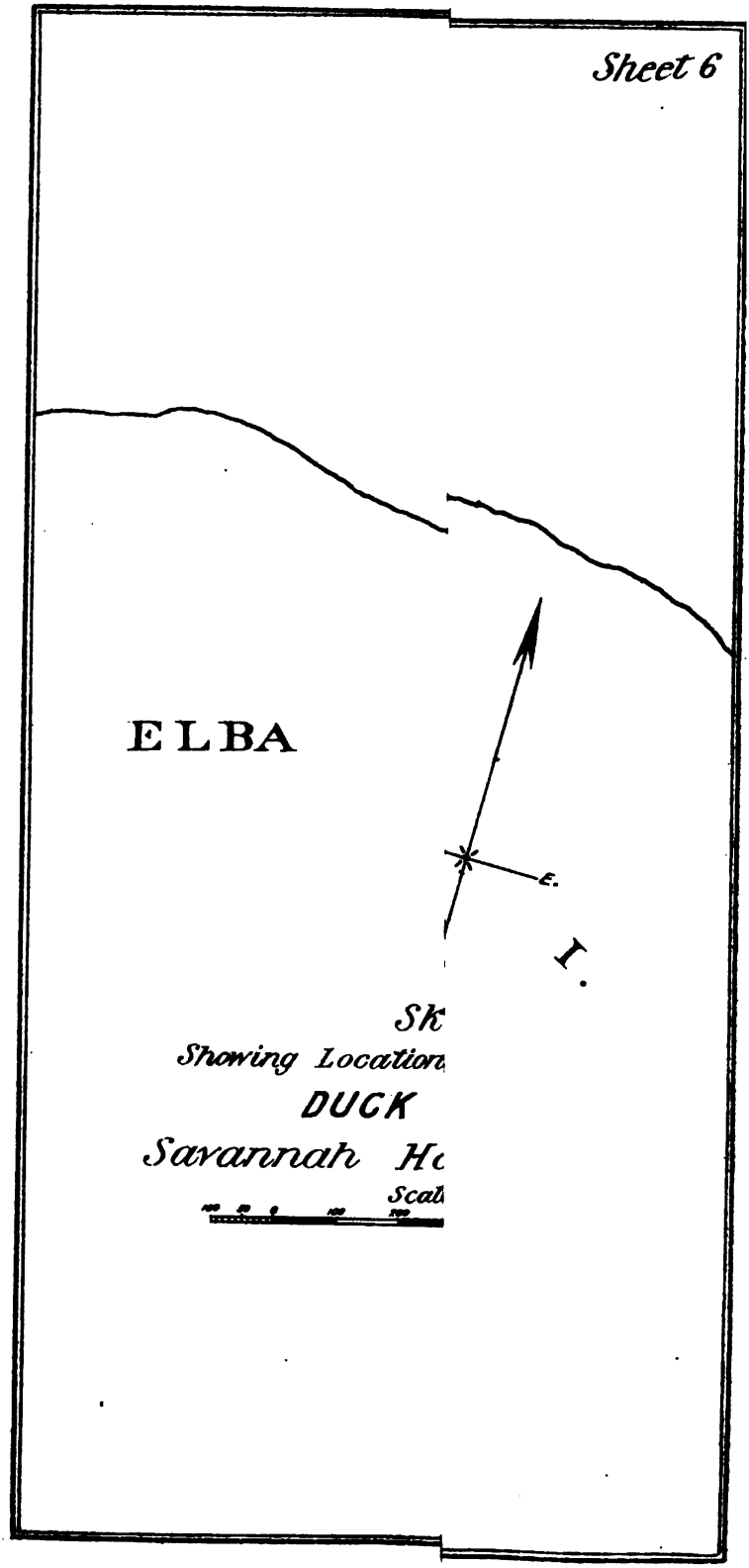
Digitized by Google

Digitized by Google



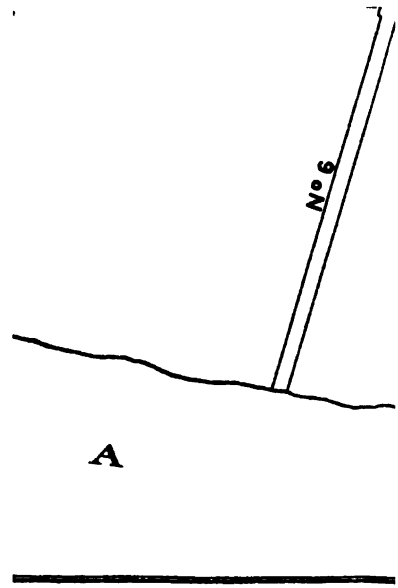
Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google

rk at

ria.

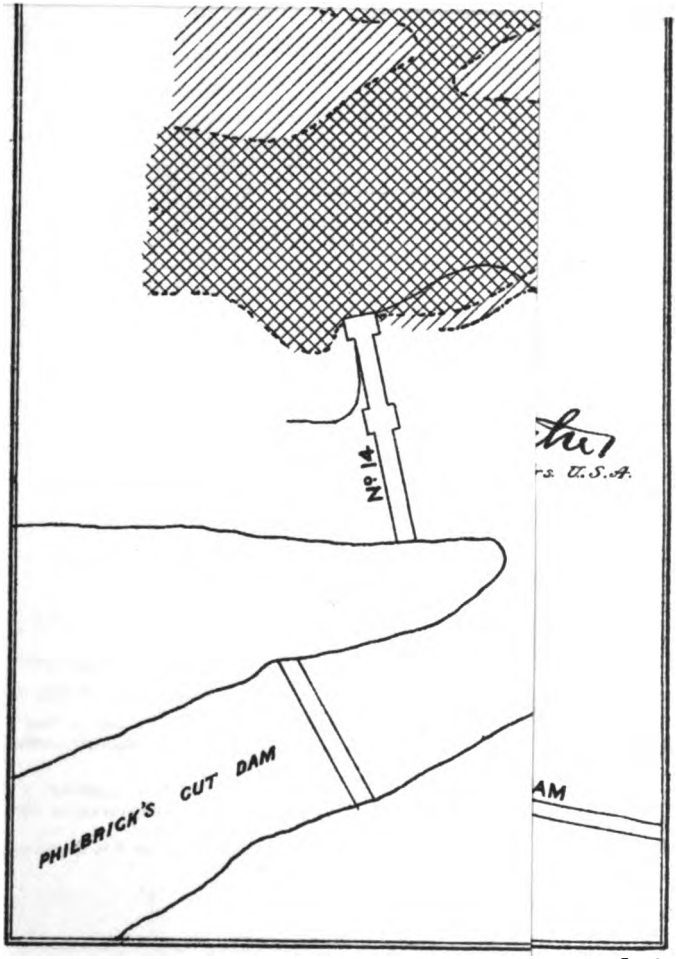
U. S. Engineer Office
Savannah, Ga. July 6,
accompany annual

Capt. Corp

RANGE BE

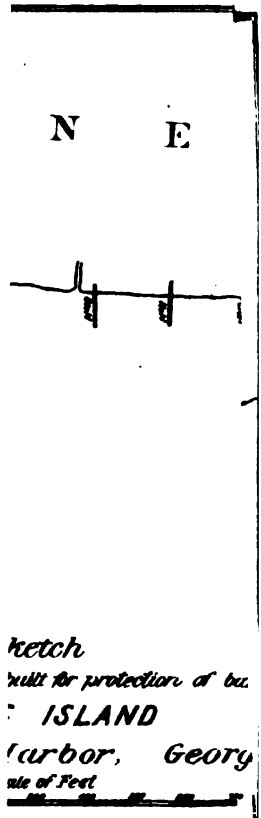
Digitized by Google

Digitized by Google



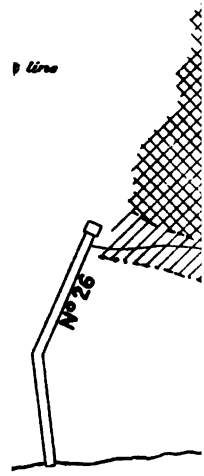
Digitized by Google

Digitized by Google


N E
ketch
uilt for protection of ba
ISLAND
Harbor, Georg
ale of Feet

To

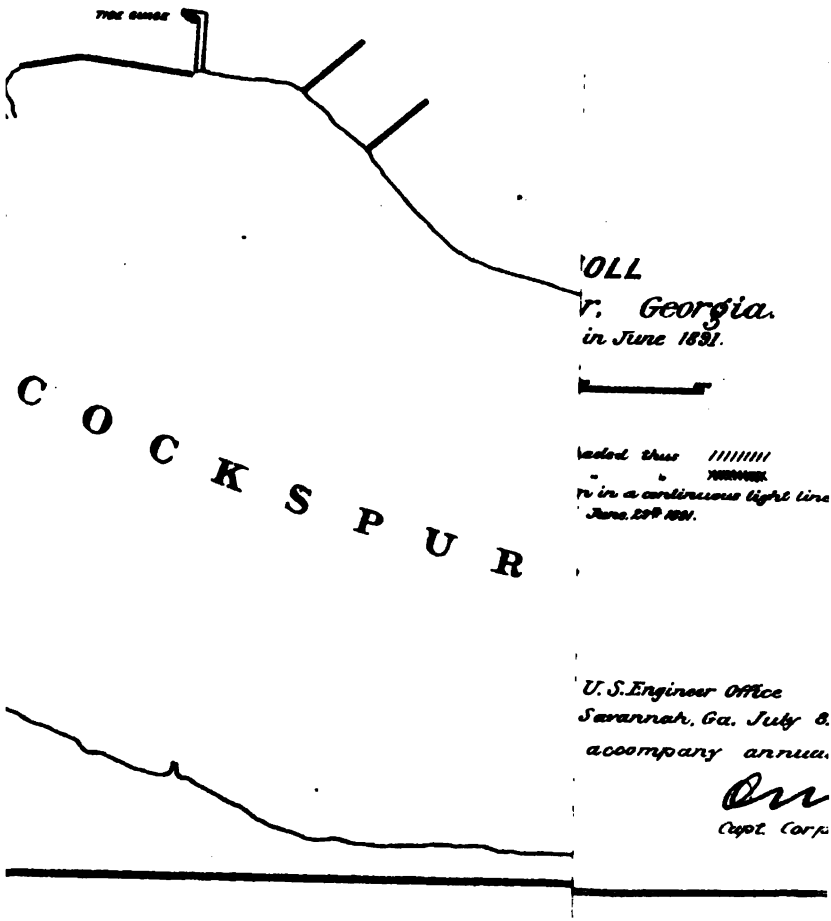
Digitized by Google



L

Digitized by Google

Digitized by Google



Digitized by Google

and these small gaps have rapidly enlarged under the influence of storms. All of the other closing dams are in good order, although they have settled slightly in some cases.

COMMERCE AND NAVIGATION.

The commerce of Savannah, which had rapidly increased, consequent on the improvement of the harbor, has continued to grow, amounting during the past calendar year to $153,000,000, and bidding fair to exceed during the present that of any former year.

The entrance into Savannah of the Savannah, Americus, and Montgomery Railway was mentioned in my last annual report. This year will witness the completion of the South Bound Railway, which will open to Savannah a short and independent route to the North. Two new railroads, the Macon and Atlantic and the Middle Georgia and Atlantic, both now under construction, will, it is expected, soon be running their trains into Savannah.

The Central Railroad of Georgia recently added to its already large system 247 more miles, making a total mileage on June 1, 1891, of 1,550 *miles*. This system, as well as the Carolina system of about 300 miles, the auxiliary roads, and the Ocean Steamship Company's lines, are now operated by the Richmond and Danville Railroad Company. It now forms, with the Union Pacific and the Missouri Pacific Railroads, practically under one ownership, a through trunk line from the Pacific coast at Portland, Oregon, to the Atlantic seaboard at Savannah, coördinate with the great northern trunk lines, and with the advantage of being shorter by some 200 or 300 miles and less subject to snow and ice blockades during the winter months than the more northerly lines.

The Alabama Midland Railway having passed into the control of the Savannah, Florida and Western Railway, has added 150 miles to that system, making a total mileage of over 900 miles, while steamboat and steamship lines, covering nearly 1,000 miles, are also embraced in this system. The Savannah, Americus and Montgomery Railway, and the Savannah and Western Railway, are also extending their lines.

In addition to the railroads, the Savannah River, navigable as far as Augusta, a distance of 202 miles by the river, for boats drawing from 4 to 5 feet, affords another means of communication with the interior; and a number of small steamers and sailing craft ply the inland route along the adjacent coast, gathering the products of the sea, and rice from the plantations, for transshipment at Savannah.

These avenues of commerce bring to Savannah the cotton, lumber, naval stores, farm and mineral products of large portions of the States of Georgia, South Carolina, Florida, Alabama, and Tennessee, as well as other classes of through freights from the West and Northwest.

Regular lines of steamships have been established between this port and Boston, New York, Philadelphia, and Baltimore. The table given below shows the number of steamships in these lines, the number of voyages made, and the tons of freight carried by them. The last item has increased nearly 13 per cent. of its value for the previous year. The passenger traffic on these lines has also increased, 11,867 persons arriving and 12,425 departing during the calendar year of 1890.

A large fleet of vessels is also engaged in the Savannah coasting trade. About one-third of the exports are to foreign ports, and in this foreign trade are engaged many foreign steamers and sailing vessels of large draft and tonnage.

Vessels entering the port are now limited to a draft of from 21 to 22 feet. During 1890, the greatest draft taken from the city to the sea on a single tide was the British barque *Nellie T. Quest*, drawing 20 feet 9

Digitized by Google

inches, while the steamship *Capulet*, drawing 20 feet, came from the sea to the city on a single tide. Recent work has somewhat increased the navigable depth.

The extension of the connections of existing railroads, the construction of new lines centering in Savannah, and the creation of greater facilities for the handling and transshipment of freights will cause to be brought to Savannah in the near future a constantly increasing volume of commerce seeking an outlet to coastwise and foreign ports. The chief exports—cotton, lumber, and naval stores—are bulky freights, and can not be carried economically by light-draft vessels under either steam or sail. Moreover, the value of the high speed of the steamships on the lines between Savannah and the northern ports is partially neutralized by their being compelled to wait for a stage of tide at which they can safely enter or leave the harbor.

Savannah's cotton receipts for the season beginning September 1, 1890, reached on June 30, 1891, 1,115,704 bales, making her the only city in the world, with the exception of New Orleans, which has received and shipped over 1,000,000 bales of cotton in one season. By estimating the receipts for the remaining months of the season on the basis of those during the same months of previous years, the probable total receipts for the present season are placed at 1,250,000 bales. The table of cotton receipts at Savannah for each season since 1872, given below, shows the steady increase in the number of bales received from year to year, and the very rapid increase during the past three seasons. In the care of the cotton received and in facilities for its shipment it is asserted that Savannah stands unrivaled. Savannah, therefore, still maintains her position as the second cotton port in the country, and continues the greatest naval stores port in the world. Of the latter commodity, there were received at and shipped from this port during the year ending March 31, 1891, 196,227 barrels of spirits of turpentine, and 770,311 barrels of rosin. Immense quantities of lumber are also received here for shipment, the output during the year being estimated at 107,371,084 feet. Phosphate rock from the Florida mines is already being brought to Savannah for shipment to foreign ports.

Past improvement of the harbor has resulted in increasing the available depth at high water from 14.5 feet to from 21 to 22 feet. The increase in the value of exports since the year 1873, when the work was begun, is proportional to the cube of the increase in the depth of water during the same period. If the same proportion should hold till a depth of 26 feet is reached, the value of the exports alone would then be about $150,000,000. The annual saving in freight rates alone, due to the increased depth, amounts to more than the total sum of money expended by the United States upon the harbor. Rates of marine insurance have also been reduced.

TABLE I.—*Cotton receipts at Savannah from 1872 to 1891.*

Season, August 31 to September 1—	Number bales.	Season, August 31 to September 1—	Number bales.
1872–'73	612,794	1882–'83	817,670
1873–'74	630,372	1883–'84	655,749
1874–'75	614,478	1884–'85	728,087
1875–'76	523,244	1885–'86	803,359
1876–'77	477,435	1886–'87	804,412
1877–'78	597,449	1887–'88	892,318
1878–'79	693,764	1888–'89	828,168
1879–'80	741,018	1889–'90	956,517
1880–'81	889,383	1890–'91	*1,250,000
1881–'82	737,056		

*Estimated.

Digitized by Google

TABLE II.—*Steamship lines.*

Line.	Savannah to—	Steamers.	Voyages.	Freight.
				Tons.
Ocean Steamship Company	New York	7	218	441,700
New England and Savannah Steamship Company.*	Boston	2	55	80,924
Merchants and Miners' Transportation Company.	Baltimore	5	77	103,107
Ocean Steamship Company	Philadelphia	1	34	32,353
Total		15	384	658,084

* Controlled by Ocean Steamship Company.

TABLE III.—*Steamers, etc., on inland waters.*

Line.	Savannah to—	Steamers.	Trips (approximate).	Freight.	Value.
				Tons.	
Savannah River	Augusta	3	129	13,360	$1,801,600
	Stoney Bluff	1	206	25,750	1,545,000
Steamer *Alpha*	Beaufort, S. C	1	36	.....	.....
Sea Island route	Fernandina, Fla	1	175	22,500	760,000
		*1			
Total		7	546	61,610	4,106,600

* One barge.

TABLE IV.—*Foreign steamers, tonnage, and bales of cotton carried by them from this port since the year 1880.*

Years.	Steamers.	Tonnage.	Bales cotton.	Years.	Steamers.	Tonnage.	Bales cotton.
1880–'81	43	44,488	203,203	1886–'87	79	95,747	407,110
1881–'82	32	36,203	157,847	1887–'88	72	86,892	345,411
1882–'83	42	52,222	237,338	1888–'89	53	65,952	274,411
1883–'84	45	54,641	238,269	1889–'90	91	118,440	487,208
1884–'85	65	73,536	303,098	1890–'91	94	124,516	522,905
1885–'86	63	71,686	310,383				

TABLE V.—*Shipping and tonnage for calendar year 1890, inward and outward bound.*

	Steam.		Sail.		Total.	
	Number.	*Tons.*	*Number.*	*Tons.*	*Number.*	*Tons.*
American	806	1,262,576	624	263,342	1,430	1,525,918
Foreign	192	233,984	426	252,398	618	486,382
Total	998	1,496,560	1,050	515,740	2,048	2,012,300

The above table includes only vessels that arrive at the city wharves, and not those that arrive at Tybee or quarantine, nor vessels of less than 100 tons burden, nor vessels and steamers plying the inland waters of the State.

Digitized by Google

TABLE VI.—*Freight rates on cotton by steam to foreign ports, in sixty-fourths of a penny per pound, since the year 1879.*

October and November.	Liverpool.	Bremen.	Havre.	Reval.	Genoa.	Barcelona.	October and November.	Liverpool.	Bremen.	Havre.	Reval.	Genoa.	Barcelona.
1879	28	30	....	32	....	....	1885	19	20	21	22	24	23
1880	24	28	....	....	....	....	1886	18	19	20	20	....	22
1881	22	24	....	28	....	....	1887	18	19	....	22	23	23
1882	26	26	28	30	30	30	1888	28	28	28	32	32	30
1883	22	24	24	26	....	....	1889	24	25	26	28	28	28
1884	20	22	....	24	....	26	1890	18	19	20	23	25	....

The foregoing table shows the decrease in foreign freight rates during the period covered to be from 28 to 37 per cent. There have been set backs due to temporary causes, notably the one in 1888, from which the freight market has scarcely yet recovered, but on the whole the tendency is steadily downward.

TABLE VII.

1890.	American.			British.			Norwegian.			Spanish.		
	Steam.	Sail.	Total.	Steam.	Sail.	Total.	Steam.	Sail.	Total.	Steam.	Sail.	Total.
January	52,106	13,491	65,597	6,793	870	7,663	344	6,204	6,548	.....	973	973
February	45,882	13,101	58,983	4,556	945	5,501	344	7,118	7,462	.....	.....	.....
March	54,061	9,074	63,135	2,281	1,400	3,681	.....	6,115	6,115	.....	327	327
April	53,082	10,429	63,511	1,686	.....	1,686	379	3,742	4,121	.....	.....	.....
May	52,050	11,414	63,464	1,322	.....	1,322	379	2,854	3,233	.....	.....	.....
June	46,447	7,555	54,002	.....	.....	.....	.....	5,402	5,402	.....	.....	.....
July	49,786	4,399	54,185	.....	841	841	.....	2,460	2,460	.....	1,857	1,857
August	51,542	8,568	60,110	2,320	.....	2,320	.....	2,588	2,588	.....	1,446	1,446
September	55,581	8,012	63,593	25,842	1,548	27,390	.....	2,159	2,159	.....	1,181	1,181
October	55,530	11,335	66,865	18,340	809	19,149	700	3,785	4,485	1,544	.....	1,544
November	56,649	18,474	75,123	23,206	1,859	25,065	350	6,791	7,141	4,815	436	5,251
December	58,572	15,819	74,391	18,816	3,930	22,746	700	2,150	2,850	.....	139	139
Total	631,288	131,671	762,959	105,162	12,202	117,364	3,196	51,368	54,564	6,359	6,359	12,718

1890.	German.			Austrian, sail.	Russian, sail.	Swedish, sail.	Portuguese, steam and sail.	Belgian, sail.	Brazilian, sail.	Italian, sail.	Total.
	Steam.	Sail.	Total.								
January	.....	3,215	3,215	752	1,776	448	.....	.....	.....	.....	86,972
February	.....	3,052	3,052	1,129	2,057	2,250	.....	.....	.....	503	80,937
March	.....	2,456	2,456	.....	1,666	2,230	468	.....	.....	1,270	81,348
April	.....	2,134	2,134	651	762	857	590	.....	.....	1,235	75,547
May	.....	2,724	2,724	1,235	.....	516	521	498	.....	550	74,063
June	.....	453	453	.....	428	.....	.....	.....	.....	.....	60,285
July	.....	.....	.....	.....	.....	1,072	1,009	.....	.....	751	62,175
August	.....	784	784	.....	.....	.....	898	.....	.....	.....	68,146
September	1,188	2,599	3,787	.....	618	.....	1,074	498	811	.....	101,111
October	1,087	.....	1,087	920	.....	.....	.....	.....	.....	.....	94,050
November	.....	1,655	1,655	796	546	670	1,020–1,020	.....	.....	664	117,931
December	.....	923	923	568	.....	770	.....	.....	.....	1,198	103,585
Total	2,275	19,995	22,270	6,051	7,853	8,813	1,020–5,580	996	811	6,171	1,006,150

Digitized by Google

TABLE VIII.—*Table giving description and nationality of vessels entering Savannah Harbor, 1890.*

Months.	American.					British.				
	Steamships.	Barks.	Brigs.	Schooners.	Total.	Steamships.	Barks.	Brigs.	Schooners.	Total.
January	34	.....	.....	33	67	5	1	1	1	8
February	30	.....	1	31	62	4	1	.....	1	6
March	34	.....	.....	23	57	2	2	.....	1	5
April	33	1	1	22	57	2	.....	.....	.....	2
May	31	.....	1	27	59	1	.....	.....	.....	1
June	31	.....	1	18	50	.....	2	.....	.....	2
July	32	1	1	9	43	.....	.....	.....	.....	.....
August	34	4	2	14	54	2	.....	.....	.....	2
September	35	2	1	17	55	19	2	.....	.....	21
October	35	2	2	20	59	14	1	.....	.....	15
November	36	3	1	38	78	17	3	.....	.....	20
December	38	1	1	34	74	14	5	.....	.....	19
Total	403	14	12	286	715	80	17	1	3	101

Months.	Norwegian.					German.			Spanish.				Portuguese.			
	Steamships.	Ships.	Barks.	Brigs.	Total.	Steamships.	Barks.	Total.	Steamships.	Barks.	Brigs.	Total.	Ships.	Barks.	Brigs.	Total.
January	1	1	9	....	11	.....	6	6	....	....	....	....	....	....	....	....
February	1	....	14	....	15	.....	5	5	....	1	1	2	....	....	....	....
March	....	....	11	....	11	.....	4	4	....	....	1	1	....	1	....	1
April	1	....	7	....	8	.....	4	4	....	....	....	....	....	1	....	1
May	1	....	5	....	6	.....	5	5	....	....	....	....	....	1	....	1
June	....	....	11	....	11	.....	1	1	....	....	....	....	....	....	....	....
July	....	....	4	....	4	.....	....	....	....	3	1	4	....	2	....	2
August	....	....	5	....	5	.....	2	2	1	....	....	1	....	1	1	2
September	....	....	4	1	5	1	2	4	....	1	1	2	....	1	....	1
October	2	....	5	....	7	1	....	1	1	....	....	1	....	....	....	....
November	1	....	12	....	13	....	1	1	2	1	....	3	1	1	....	2
December	2	....	4	....	6	....	....	2	2	1	....	1	....	....	....	....
Total	9	1	91	1	102	2	2	32	36	4	7	4	15	1	8	1	10

Month.	Swedish.			Russian.		Belgian.		Italian.		Austrian.			Brazilian.	
	Barks.	Brigs.	Total.	Barks.	Total.	Barks.	Total.	Barks.	Total.	Barks.	Brigs.	Total.	Barks.	Total.
January	1	....	1	3	3	....	.....	.....	.....	1	....	1	....	.....
February	5	....	5	3	3	....	.....	1	1	2	....	2	....	.....
March	4	....	4	3	3	....	.....	2	2	2	....	2	....	.....
April	1	1	2	1	1	....	.....	2	2	1	....	1	....	.....
May	1	....	1	.....	.....	1	1	1	1	2	....	2	.....	.....
June	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	1	1	2	....	.....	....	.....	1	1	....	....	.....	.....	.....
August	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September	.....	.....	.....	1	1	1	1	.....	.....	.....	.....	.....	1	1
October	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	....	1	.....	.....
November	1	....	1	1	1	....	.....	1	1	1	....	1	....	.....
December	1	....	1	.....	.....	....	.....	2	2	....	1	1	....	.....
Total	15	2	17	13	13	2	2	10	10	10	1	11	1	1

Digitized by Google

TABLE VIII.—*Table giving description and nationality of vessels entering Savannah Harbor, 1890*—Continued.

TOTALS.

Months.	Steamships.	Ships.	Barks.	Brigs.	Schooners.	Grand total.
January	40	1	21	1	34	97
February	35	.....	22	2	32	91
March	36	.....	29	1	24	90
April	36	.....	18	2	22	78
May	33	.....	16	1	27	77
June	31	.....	15	1	18	65
July	32	.....	12	3	9	56
August	37	.....	12	3	14	66
September	55	1	15	3	18	92
October	53	.....	9	2	20	84
November	57	1	25	1	38	122
December	54	.....	17	1	34	106
Total	499	3	211	21	290	1,034

TABLE IX.—*Principal shipments and exports from Savannah, Ga., for the year ending March 31, 1891.*

Articles.	Coastwise.	Foreign.	Total.	Value.
Lumber and timber ..... sup. feet..	89,070,238	18,300,849	107,381,084	$1,287,452
Staves	996,111	2,625	998,836	99,837
Shingles	7,169,122	.....	7,169,122	143,380
Fruit and vegetables ..... packages..	1,100,778	.....	1,100,778	3,000,000
Cotton:				
Sea Island ..... bales..	16,635	22,134	38,769	3,876,900
Upland ..... do...	445,213	555,118	1,000,331	50,016,550
Turpentine ..... barrels..	75,067	121,160	196,227	4,395,344
Rosin ..... do...	381,418	388,893	770,311	1,540,622
Hides ..... bundles..	6,017	.....	6,017	60,770
Melons	683,810	.....	683,810	68,381
Wool ..... bales..	6,458	.....	6,458	322,900
Cotton-seed oil ..... barrels..	37,416	.....	37,416	374,160
Casks clay	4,277	.....	4,277	.....
Pig iron ..... tons..	469,901½	.....	469,901½	9,398,030
Rice, merchandise, etc	.....	.....	.....	10,000,000
Total	.....	.....	.....	84,584,326

Receipts and imports at Savannah, Ga., of the principal articles of commerce for the year ending March 31, 1891.

Articles.	Quantity.	Value.
Lumber and timber ..... sup. feet..	128,685,010	$1,544,220
Spirits of turpentine ..... barrels..	196,166	8,923,320
Rosin ..... do...	798,615	1,597,230
Corn ..... bushels..	491,054	428,448
Oats ..... do...	798,615	479,169
Meal ..... do...	27,296	38,760
Flour ..... do...	75,000	1,271,500
Grist ..... do...	21,379	30,358
Bacon ..... pounds..	25,971,525	1,818,006
Lard ..... do...	2,608,488	130,424
Bran ..... do...	5,763,605	288,180
Coffee (coastwise only) ..... sacks..	13,141	394,230
Hay ..... bales..	138,015	123,015
Rice ..... bushels..	483,082	483,082
Cotton:		
Sea Island ..... bales..	44,382	4,438,200
Upland ..... do...	1,032,041	51,602,050
Salt (foreign only) ..... pounds..	14,301,397	143,014
Cigars ..... number..	302,600	15,130
Fertilizers ..... tons..	9,033	223,325
Molasses ..... gallons..	83,362	16,672
Cotton ties ..... bundles..	42,059	56,778
Muriate of potash ..... pounds..	4,715,492	47,155
Nitrate of soda ..... do...	1,665,902	16,659
Brimstone ..... tons..	6,045	120,900
Total	.....	68,229,825

Digitized by Google

MISCELLANEOUS.

The river is in fair condition, but the work has not progressed satisfactorily and its cost has been much increased owing to irregular and inadequate appropriations. Future operations should be carried on simultaneously throughout the whole extent of the river, and to secure successful and permanent results dredging should be accompanied or promptly followed by contracting works. To secure the fullest benefits from the improvements already executed and in order that the future growth of the port may not be seriously retarded, it should be enabled to furnish an outlet for the rapidly growing commerce brought from the interior. It is proposed to expend any funds which may become available during the year in the construction of training walls and in dredging, as provided for in the project for securing a depth of 26 feet at mean high water.

A vigorous and economical prosecution of the work will be possible only with regular and adequate appropriations. The insufficient and irregular appropriations of the past have rendered satisfactory progress impossible and have increased the cost of the work in some instances as much as 100 per cent. The sum asked for during the next fiscal year is $1,000,000. The most desirable and satisfactory results can not be obtained with an expenditure during the year of a less amount.

The work is located in the collection district of Savannah, Ga. Savannah is the port of entry. Amount of duties collected in 1890, $57,542.57. The nearest lighthouses are those upon the river, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving Savannah Harbor was adopted one appropriation of $35,000 has been made and an unexpended balance of $4,035.05 transferred from a former appropriation.

The total expenditures under the present project to June 30, 1891, including all outstanding liabilities, were $277,943.49.

Money statement.

July 1, 1890, balance unexpended		$4,035.05
Amount appropriated by act approved September 19, 1890		350,000.00
		354,035.05
June 30, 1891, amount expended during fiscal year		212,148.91
July 1, 1891, balance unexpended		141,886.14
July 1, 1891, outstanding liabilities	$65,794.58	
July 1, 1891, amount covered by uncompleted contracts	60,984.70	
		126,779.28
July 1, 1891, balance available		15,106.86
Amount (estimated) required for completion of existing project		3,150,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Digitized by Google

Abstracts of proposals for stone, mattress, and pile work in Savannah Harbor and River, Georgia, opened October 20, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price for—				Total amount.
		Mattresses.	Riprap stone.	Brush.	Pile work.	
		Sq. yd.	*Cu. yd.*	*Cu. yd.*	*Cu. ft.*	
1	Alabama Dredging and Jetty Company, E. L. Merkel, president, Mobile, Ala..	$0.90	$3.05	$1.40	$1.90	$235,900
2	P. Sanford Ross, Jersey City, N. J	.95	3.25	1.50	.30	234,000
3	John F. Gaynor, Fayetteville, N. Y.*.....	.85	3.00	1.40	1.50	227,500

REMARKS.—Amount available, about $235,000.
*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable materials and service.

Abstract of proposals for dredging in Savannah River, Georgia, opened October 15, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.
1	P. Sanford Ross, Jersey City N. J.*	$0.18
2	Savannah Dredging Company, Jacob Paulsen, president, Savannah, Ga	.18½
3	American Dredging Company, Isaac Albertson, president, Philadelphia, Pa	.19½

*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable service.
Amount available, about $90,000.

COMMERCIAL STATISTICS.

Cotton statistics of the port of Savannah, Ga., for the commercial year ending August 31, 1890.

[By J. P. Merrihew, superintendent Savannah Cotton Exchange.]

Receipts from all sources.	Quantity.	Weight.	Value.
	Bales.	*Pounds.*	
Upland	924,282	449,284,237	$45,964,544
Sea island	32,235	12,465,919	3,198,356
Total	956,517	461,750,156	49,162,900

Exports from Savannah.	Upland.	Sea island.
	Bales.	*Bales.*
Coastwise	401,378	16,942
Great Britain	137,912	15,150
France	29,684	542
Other continental ports	347,891	230
Mill consumption	360	.....
Destroyed by fire	4,242	17
Total	921,467	32,881

Digitized by Google

Cotton statistics of the port of Savannah, Ga., etc.—Continued.

Total exports, etc.	Quantity.	Weight.	Value.
	Bales.	*Pounds.*	
Upland	921,467	447,915,894	$45,824,554
Sea island	32,881	12,715,750	3,262,452
Total	954,348	460,631,634	49,087,006

Foreign exports:			Coastwise exports:		
Upland	bales..	515,487	Upland	bales..	401,378
Sea island	do....	15,922	Sea island	do....	16,942
Average value per bale:			Average weight per bale:		
Upland		$49.73	Upland	pounds..	486.09
Sea island		99.22	Sea island	do....	386.72

Arrival and clearance of vessels and commerce at Savannah, Ga., from January 1, 1873, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
													Feet.
1873	463	381,595	11,934	34	16,140	383	213	119,316	2,999	710	517,051	15,316	17.50
1874	418	354,700	10,048	66	41,030	847	284	182,517	4,232	768	578,247	15,127	17.50
1875	370	310,877	10,102	67	39,832	781	222	145,748	3,290	659	495,923	14,173	17.50
1876	355	320,015	10,348	58	40,298	987	260	169,640	3,865	673	530,496	15,200	17.75
1877	333	379,826	10,867	54	40,948	951	287	168,247	3,950	674	589,021	15,768	18.25
1878	322	385,532	10,688	61	45,208	576	326	235,787	5,814	709	666,527	18,078	18.50
1879	319	414,794	8,235	30	21,994	1,576	279	198,040	3,960	628	634,828	12,634	17.75
1880	338	446,881	9,996	14	7,724	439	244	172,224	3,583	596	626,829	13,699	18.33
1881	383	508,422	11,069	21	10,729	170	254	151,463	3,474	658	670,614	14,780	19.00
1882	391	544,488	12,605	11	4,865	237	204	115,061	2,718	606	666,374	16,429	19.00
1883	390	468,226	10,659	10	4,115	106	160	87,020	1,965	550	559,366	12,714	18.25
1884	388	482,917	13,735	14	5,632	90	287	174,676	3,984	689	663,225	17,835	19.00
1885	395	493,610	14,622	12	5,058	116	251	163,321	3,416	658	668,989	18,163	20.75
1886	393	503,073	14,534	10	5,952	125	268	177,229	3,719	671	686,254	18,438	20.00
1887	430	543,235	15,127	8	2,725	185	231	130,136	2,800	669	676,096	17,987	20.40
1888	411	539,576	14,907	8	8,560	60	229	146,075	3,288	648	689,211	18,306	20.67
1889	409	561,463	15,547	12	6,563	111	309	215,865	4,530	730	783,891	20,231	20.70
1890	483	717,561	19,178	9	2,303	69	300	193,263	4,058	792	913,217	23,305	20.00

CLEARED.

1873	466	398,050	13,749	65	30,102	689	224	129,164	3,194	755	557,316	17,632	17.50
1874	480	467,295	12,748	71	40,397	822	229	145,038	3,437	780	592,730	17,007	17.50
1875	319	234,331	9,376	72	39,311	804	195	128,086	2,924	586	452,228	13,104	17.50
1876	410	361,999	11,222	80	49,483	1,163	185	119,699	2,827	675	531,781	15,212	17.75
1877	400	439,370	12,081	65	44,829	1,066	161	103,342	2,489	626	587,541	15,736	18.25
1878	378	418,958	10,475	64	40,128	1,255	260	183,757	5,375	702	642,843	17,105	18.50
1879	365	442,734	8,834	36	24,891	497	223	156,470	3,129	624	624,095	12,460	17.75
1880	319	434,864	10,108	26	12,536	271	243	168,255	3,446	578	615,655	13,825	18.33
1881	369	508,422	11,458	22	13,052	253	261	180,579	3,745	652	702,053	15,456	19.00
1882	350	506,213	11,917	23	9,155	206	209	135,375	3,023	582	650,743	15,145	19.00
1883	355	415,720	9,780	10	4,115	90	165	87,400	2,015	530	507,235	11,885	18.25
1884	360	452,802	13,383	15	5,634	131	288	194,075	4,815	663	652,411	17,809	19.00
1885	414	502,773	14,672	20	8,722	148	228	154,858	3,344	662	666,353	18,164	20.17
1886	378	473,134	13,912	3	939	24	262	194,793	3,970	643	668,867	17,906	20.00
1887	380	480,030	14,167	4	678	29	269	202,656	4,186	653	683,364	18,382	20.00
1888	382	507,075	14,231	8	2,583	63	233	167,836	3,557	623	677,494	17,851	.....
1889	395	540,296	15,505	7	1,323	51	307	226,181	4,601	711	767,747	20,157	.....
1890	452	663,227	18,815	14	4,087	161	323	248,013	5,078	789	915,327	24,054	20.75

T. F. JOHNSON,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

Digitized by Google

Commerce at Savannah, Ga., etc.—Continued.

COMMERCE.

Years.	Value of exports.	Value of imports.	Duties collected.	Years.	Value of exports.	Value of imports.	Duties collected.
1877	$32,108,853	$36,307,908	$34,959.93	1884	$46,425,513	$49,112,316	$49,147.28
1878	40,028,988	42,948,465	23,364.35	1885	48,313,216	49,881,080	45,161.40
1879	40,901,421	43,064,472	27,778.73	1886	51,033,190	51,118,524	35,455.53
1880	47,836,411	45,522,480	78,458.41	1887	54,774,082	52,659,223	48,837.12
1881	58,985,901	48,716,900	356,550.22	1888	56,435,601	53,412,920	98,213.75
1882	52,004,248	45,952,105	61,148.70	1889	62,892,429	55,062,710	58,815.54
1883	53,915,934	47,699,796	65,245.34	1890	84,584,326	68,229,825	57,542.57

REPORT OF CAPTAIN O. M. CARTER, CORPS OF ENGINEERS, ON WIDTH BETWEEN TRAINING WALLS PROPOSED FOR SAVANNAH HARBOR.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1891.

GENERAL: In my project of August 25, 1887, for the improvement of Savannah Harbor, Georgia, I discussed generally the subject of canalizing the river, and assumed provisionally a splay of from 10 to 15 in 1,000 for the upper reaches of the river and of about 20 in 1,000 for its lower reaches, the width of the channel increasing from 600 feet opposite the city to about 2,000 feet at Tybee Knoll.

With a view of securing data for a more accurate determination of the proper form for the improved channel and for a general revision of my project of improvement a detailed survey of the harbor and river was made under my direction in 1889 and 1890, and reported upon in my revised project of June 30, 1890.

Sufficient time was then not available to make a study, with especial reference to the determination of the proper splay to be given to the river funnel, of the data afforded by that survey. This study has since been made, under my direction, by Mr. E. A. Gieseler, assistant engineer. While no material change in the location of the training walls as originally proposed by me has been found necessary or desirable, more complete data than ever before have been available for the study of the subject, and the results obtained are of much value.

Mr. Gieseler's report covers the ground so fully that I beg to submit it entire (Appendix I).

The discussion of the form of funnel for the Savannah River afforded an opportunity for a general investigation regarding the physical conditions governing tidal phenomena in rivers. Such data as I was able to obtain have been analyzed by Mr. Gieseler. His studies seem to indicate the existence of a general law by means of which, given certain data, among them the tidal range and the area of the tidal basin above any cross section in a tidal stream, there may be determined the cross-sectional area required to propagate the tidal wave with undiminished range. It appears probable also that there may be discovered a general law permitting the determination of the proper cross section for the transmission of the tidal wave with any given rate of decrease. While the formulæ given in Mr. Gieseler's paper are based upon very meager data and need further confirmation, his study of the subject is the most valuable that has yet been made.

The studies entered upon promising results of great practical value, authority was sought to carry them further. This was denied, and,

Digitized by Google

there being no prospect of completing the unfinished work, Mr. Gieseler's preliminary report is submitted herewith (Appendix II).

Respectfully submitted.

O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. E. A. GIESELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., May 18, 1891.

CAPTAIN: I have the honor to submit the following report in regard to the distance between training walls proposed for the improvement of Savannah Harbor, Georgia:

The basis of this report is formed by the results of gauging operations reported upon by me under dates of January 31 and June 9, 1890, and by the soundings taken in the summer of the same year, which have, in the meantime, been platted on the same scale on which the map of 1887 was platted. Cross sections at an average distance of 1,000 feet were taken from this map and platted on six sheets, which are submitted herewith. Besides these, the following diagrams* accompany this report:

Sheet No. 1.—Diagram showing mean elevation of surface during mean ebb and flood flow and duration of same in Front River and North Channel, Savannah Harbor, from current observations made in 1889 and 1890.

Sheet No. 2.—Diagram showing cross-sectional areas at mean surface of mean ebb flow in Front River and North Channel, Savannah Harbor, from survey made in 1890.

Sheet No. 3.—Diagram showing ebb and flood volumes in Front River and North Channel, Savannah Harbor, from current observations made in 1889 and 1890.

From the diagrams the appended tables 1 and 2 were constructed, the former giving width, cross-sectional area, mean depth, and channel depth at high water, while the latter gives the same data at mean surface of ebb flow, and, in addition to this, ebb discharge and mean ebb velocity. According to all this information the state of the river in 1890 may be summed up as follows:

1. Front River, from Taylor's Mill to lower end of Wrecks Channel; sections B to 32; distance, 6.2 miles.

On this stretch of the river the widths vary between 500 and 1,100 feet and the high-water cross-sectional areas between 11,000 and 18,000 square feet, the average being 14,300 square feet; the ebb volume increases steadily from about 600 to about 700,000,000 cubic feet, and the mean ebb velocity varies from somewhat more than 1½ feet to 2½ feet per second, the average being 2.1 feet. Above the Central Railroad docks the high-water channel depths in places is less than 15 feet. Below the Central Railroad docks the high water channel depths vary between about 18 and about 27 feet, the average being 23½ feet.

2. From the lower end of Wrecks Channel to the mouth of South Channel; sections 33 to 39; distance, 1.4 miles.

Here the widths vary from about 1,500 feet to about 2,700 feet, and the size of high-water cross-sectional areas from 37,000 to 43,000 square feet. Our information in regard to the volumes moving here is not definite, because we do not know the proportion between the discharges of the two lower mouths of Back River. It has been assumed here that of the 1,000,000,000 cubic feet of Back River ebb volume 700,000,000 cubic feet pass into Front River at the lower end of Wrecks Channel and 300,000,000 cubic feet pass out of the opening between Barnwell Island No. 3 and the Carolina shore. It has been further assumed that the addition of these 700,000,000 cubic feet to the Front River flow is equally distributed over the three sections, 33, 34, and 35. It is probable, however, that this addition has almost entirely taken place at section 33 already, in which case the mean velocities at sections 33 and 34, as given in the tables, are of course too small. Taking this circumstance into consideration, it appears probable that the mean ebb velocity on this stretch averages about 1.8 feet. An excellent channel of more than the required depth is maintained here.

3. From mouth of South Channel to Duck Puddle; sections 40 to 43; distance, 1 mile.

Here the widths vary from about 1,400 to about 2,000 feet and the high-water cross-sectional areas from about 25,000 to about 38,000 square feet; the ebb volume (which

* Omitted.

Digitized by Google

underlies the same doubt as above) is diminished at the mouth of South Channel from 1,500,000,000 to 800,000,000 cubic feet, and is then increased at the lower mouth of Back River to 1,100,000,000 cubic feet, while the mean velocity averages about 1¼ feet per second. The high-water channel depth on this stretch varies between 22 and 25 feet.

4. From the upper to the lower mouth of Duck Puddle; sections, 44 to 49; distance 1.3 miles.

Here the widths vary from 1,100 to 1,550 feet and the high-water cross-sectional areas from 29,000 to 32,300 square feet; the ebb volume, after having been slightly diminished by the Duck Puddle flow, steadily increases from 1,060,000 to 1,100,000,000 cubic feet, and the mean ebb velocity averages 1.7 feet. An excellent channel of more than the required depth is maintained throughout this stretch.

5. From the lower mouth of Duck Puddle to the mouth of Wright River; sections 50 to 75; distance 5.3 miles.

Here the widths at mean surface of ebb flow vary greatly, on account of the contraction at various places by means of wing dams. Between wing dams 6 and 25 the width is only 1,160 feet, while the unrestricted river expands to as much as 5,000 feet. The ebb volume, after having taken up the Duck Puddle flow, increases steadily from about 1,200,000,000 to about 1,750,000,000 cubic feet; the mean ebb velocities vary between somewhat less than 1+¼ feet and somewhat more than 2 feet, and the high-water channel depth ranges from 20 feet to more than 30 feet.

In order now to arrive at a basis in regard to the channel dimensions needed, first in Front River, so as to maintain there a depth of 26 feet at high water, we proceed to consider the conditions in that part of the river, where the channel at present conforms most to what it is desired to obtain, viz, the stretch lying between Kinzey's Dock and the Savannah, Florida and Western Railway wharves, sections 13 to 24. Taking means of all these sections we find that in this region, to a mean depth of 17.3 feet at mean surface of ebb flow, there corresponds a channel depth at high water of 24.5 feet, which leads to the conclusion that to a mean depth at mean surface of ebb flow of somewhat more than 18 feet there would correspond the desired channel depth of 26 feet at high water.

On the basis of a mean depth of 19 feet at mean surface of ebb flow and a mean ebb velocity of 2 feet per second, areas and widths have been computed for Front River and are rendered in table No. 3. On the whole, contraction of width is required, excepting in the vicinity of the city exchange, where the present width appears to be too narrow.

The stretch of river lying immediately below Front River requires no improvement, channel depths more than sufficient prevailing down to the mouth of South Channel.

From there to Duck Puddle a permament 26-foot channel is hardly possible in the presence of the enormous drain South Channel makes on the flow in the navigable part of the river.

In order to arrive at a basis in regard to the conditions required in North Channel so as to maintain there a depth of 26 feet at high water we now proceed to investigate existing circumstances at those places where the river has already been restricted. The following is an abstract from tables No. 1 and No. 2, giving the conditions of 1890 at such points where wing dams have been built:

Number of cross section.	Numbers of wing dams.	High-water channel depth.	Mean depth at mean surface of ebb flow.	Mean ebb velocity per second.	Remarks.
		Feet.	*Feet.*	*Feet.*	
50	4 and 23	25.3	18.3	1.93	
53	6 and 25	27.8	19.4	2.19	
54	10 and 27	24.3	16.1	.....	Main opening only.
59	14 and 29	26.9	18.1	2.00	
69	26 and 33	30.9	19.6	2.21	
74	28 and 40	23.9	17.5	.....	Main opening only.
Means	.....	26.5	18.2	2.08	

This leads to almost the same results concerning the required mean depth and mean ebb velocity that were obtained above from a consideration of part of Front River. But for the mean velocity there is another source of information, viz, the stretch of North Channel between Spirit Island and the Carolina shore, where, as stated above, a channel is maintained by a mean ebb velocity of 1.7 feet. It appears all the more advisable to make this smaller figure the basis of our computations, as the comtemplated construction of the Mackay Point Jetty will ultimately increase the velocities in the entire navigable river from that point down.

Digitized by Google

In accordance with these considerations the following computations have been made and their results rendered in table No. 3: The future cross-sectional area has been computed from the known discharge and starting with a future mean velocity of 1.7 feet at cross section F, which velocity is gradually increased to 2 feet at cross section 75, near mouth of Wright River. From the area so formed the required width is deduced by dividing with the assumed mean depth at mean surface of ebb flow, viz, 19 feet. The quotient would be the required width if the training walls were to be carried up to high water; but as they are for the beginning only to be carried up to low-water level, the actual profile has a considerably greater width at high water than it has at low water. The widths between training walls must, therefore, be made smaller, and in order to find what they should be we designate as follows:

H = high-water width.
a = Cross-sectional area at mean surface of ebb flow.
x = width between training walls.

Now when it is considered that mean surface of ebb flow is 2.7 feet above mean low-water (see sheet No. 1) then we have—

$a = (19 - 2.7)\,x + 2.7\,H = 16.3\,x + 2.7\,H$, from which we find—

$$x = \frac{a - 2.7\,H}{16.3}$$

According to this equation the required widths between training walls have been computed from Spirit Island down to the mouth of Wright River, H having been assumed as gradually increasing from 2,000 to 4,000 feet and Duck Puddle having been assumed as closed.

Submitting the above, I am, captain, very respectfully, your obedient servant,

E. A. GIESELER,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

TABLE NO. 1.—*Physical elements of Front River and North Channel, 1890.*

Number of cross section.	Distance between cross sections.	At mean high water.				Location.
		Width.	Area of cross section.	Mean depth.	Channel depth.	
	Feet.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	
B	.....	800	11,095	13.9	18.8	Below Taylor's Mill.
1	1,250	860	13,000	15.1	18.8	
2	1,250	900	12,727	14.1	15.4	Reed's Mill.
3	1,200	1,050	13,300	12.7	14.9	
4	1,300	1,280	14,720	11.5	16.1	Marsh Island.
5	1,550	1,200	14,840	12.4	18.2	Waterworks.
6	1,000	1,190	14,990	12.6	14.3	Lower end of Marsh Island.
7	1,000	1,620	18,310	11.3	14.8	
8	1,000	1,170	14,630	12.5	19.4	Upper end of Central Railroad Rock.
9	1,000	950	14,650	15.4	17.5	△ Upper Cypress.
10	1,100	912	14,040	15.4	23.5	
11	1,100	1,090	14,950	13.7	22.6	Above canal.
12	1,050	915	14,900	16.3	23.2	Central Railroad Elevator.
13	1,170	675	13,270	19.7	22.3	
14	1,250	535	12,280	23.0	26.9	Kinzey's Dock.
15	750	535	12,066	22.6	25.9	Savannah City Exchange.
16	750	515	11,650	22.6	24.5	Above Paulsen's Wharf.
17	810	560	12,526	22.4	26.0	
18	810	710	14,290	20.1	23.6	Barge office.
19	1,080	995	14,445	14.5	23.1	Cotton press.
20	1,180	970	14,260	14.7	23.2	Gordon's Wharf.
21	1,030	770	14,830	19.3	23.2	Bilbo Canal.
22	1,030	732	14,910	20.4	25.5	⊙ Tree.
23	980	692	14,400	20.8	26.3	Fig Island Light.
24	980	890	14,334	16.1	24.0	
25	850	895	15,410	17.2	23.4	Lower end S. F. and W. Wharf.
26	850	955	14,425	15.1	22.9	
27	950	1,050	14,190	13.5	23.8	
28	950	1,000	13,654	13.7	25.5	△ Cypress.
29	950	1,000	14,616	14.6	24.5	
30	950	1,070	15,800	14.8	21.5	
31	770	1,120	16,854	15.0	21.5	
32	750	1,100	18,240	16.6	24.6	Lower end Wreck Channel.
33	1,000	2,250	42,184	18.7	33.6	Above Fort Oglethorpe.

Digitized by Google

TABLE No. 1.—*Physical elements of Front River and North Channel, 1890*—Continued.

Number of cross section.	Distance between cross sections.	At mean high water.				Location.
		Width.	Area of cross section.	Mean depth.	Channel depth.	
	Feet.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	
34	1,120	2,280	42,030	18.4	38.6	Below Fort Oglethorpe.
35	1,050	1,580	37,300	23.6	34.1	Upper end Barnwell Island No. 2.
36	870	1,820	38,030	20.9	34.6	
37	870	2,100	39,310	18.7	36.7	
38	1,100	2,540	42,773	16.8	32.7	
39	1,100	2,720	42,855	15.8	26.7	Mouth of South Channel.
40	1,100	1,970	26,965	13.7	24.1	Wing Dam No. 15.
41	1,220	1,440	24,904	17.3	24.9	Lower end Barnwell Island, No. 3.
42	1,240	2,080	38,330	18.4	24.9	
43	1,210	1,900	35,920	18.9	24.7	Mouth of Duck Puddle.
44	1,230	1,420	31,030	21.9	39.2	
45	1,040	1,180	29,123	24.7	41.7	△ Bight.
46	1,080	1,120	29,010	25.9	40.7	
F	1,050	1,200	29,190	24.3	37.7	△ Beacon.
47	760	1,360	31,845	23.4	36.0	
48	760	1,380	32,210	23.3	33.8	
49	750	1,580	32,370	20.5	28.3	△ Bush.
50	750	1,980	30,965	15.6	25.3	Wing dams Nos. 4 and 23, lower mouth of Duck Puddle.
51	1,060	3,140	44,276	14.1	22.8	
52	1,400	3,760	37,700	10.0	27.8	Wing dams Nos. 6 and 25.
53	1,160	4,120	49,080	11.9	27.8	
54	1,140	3,920	51,135	13.0	24.0	Wing dams Nos. 10 and 27.
55	1,270	3,300	46,345	14.0	28.9	Upper Elba Island Range Beacon.
56	1,200	2,880	44,913	15.6	37.9	
57	1,270	2,580	45,050	17.5	31.9	Lower Elba Island Range Beacon.
58	1,100	2,440	44,140	18.1	25.5	
59	900	2,540	38,555	15.2	26.9	Wing dams Nos. 14 and 29.
60	1,280	2,800	50,185	17.9	21.6	
61	840	3,160	40,505	12.8	21.3	Wing Dam No. 13.
62	1,070	3,480	51,806	14.9	23.2	
63	1,050	3,700	54,944	14.8	25.9	Center of Big Gap Dam.
64	1,065	3,790	56,590	14.9	29.4	Lower end of Big Gap Dam.
65	1,065	3,415	54,680	16.0	31.4	
66	1,200	3,500	56,063	16.0	28.9	Above Venus Point, upper beacon.
67	1,340	3,760	59,880	15.9	25.7	Below Venus Point, upper beacon.
68	1,140	3,840	62,250	16.2	25.4	
69	1,140	3,540	45,356	13.0	30.9	Wing dams Nos. 26 and 33.
70	850	3,520	60,360	17.1	26.9	
71	850	3,580	61,160	17.1	25.2	
H	790	3,720	61,850	16.6	23.9	
72	790	4,050	64,856	16.0	22.9	
73	815	4,500	67,550	15.0	22.9	
74	815	4,840	61,326	12.7	23.9	Wing Dam No. 35.
75	900	5,410	77,190	14.3	22.9	Mouth of Wright River.

TABLE No. 2.—*Physical and tidal elements of Front River and North Channel, 1890.*

Number of cross section.	At mean surface of mean ebb flow.				Mean ebb.			
	Width.	Area of cross section.	Mean depth.	Channel depth.	Discharge.	Duration.	Discharge per second.	Mean velocity per second.
	Feet.	*Sq. feet.*	*Feet.*	*Feet.*	*Cubic feet.*	*Seconds.*	*Cubic feet.*	*Feet.*
B	800	8,792	11.0	15.7	599,000,000	30,420	19,691	2.24
1	860	10,365	12.1	15.8	601,000,000	30,300	19,835	1.91
2	900	9,940	11.0	12.3	603,000,000	30,180	19,980	2.01
3	1,050	10,011	9.5	11.8	606,000,000	30,060	20,160	2.01
4	1,280	10,652	8.3	12.9	611,000,000	29,940	20,407	1.92
5	1,160	10,940	9.4	14.9	617,000,000	29,760	20,733	1.90
6	1,190	11,062	9.3	11.0	624,000,000	29,700	21,010	1.90
7	1,615	12,900	8.0	11.5	631,000,000	29,580	21,332	1.65
8	1,166	10,665	9.1	16.0	636,000,000	29,520	21,515	2.02
9	945	11,395	12.1	14.1	641,000,000	29,400	21,803	1.91
10	912	10,875	11.9	20.1	643,000,000	29,280	21,960	2.02
11	1,090	11,110	10.2	19.1	644,000,000	29,160	22,085	1.99
12	915	11,650	12.7	19.6	645,000,000	29,040	22,211	1.91
13	675	10,840	16.1	18.7	648,000,000	28,980	22,360	2.06
14	535	10,330	19.3	23.2	651,000,000	28,800	22,604	2.19
15	535	10,097	18.9	22.2	652,000,000	28,740	22,690	2.25
16	515	9,744	18.9	20.7	653,000,000	28,680	22,769	2.34
17	560	10,426	18.6	22.3	654,000,000	28,620	22,851	2.19

Digitized by Google

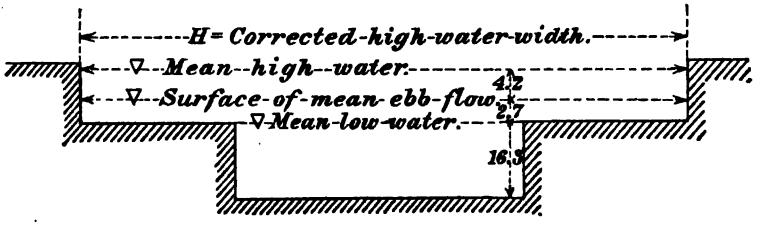
TABLE NO. 2.—*Physical and tidal elements of Front River and North Channel, 1890*—Continued.

Number of cross section.	At mean surface of mean ebb flow.				Mean ebb.			
	Width.	Area of cross section.	Mean depth.	Channel depth.	Discharge.	Duration.	Discharge per second.	Mean velocity per second.
	Feet.	*Sq. feet.*	*Feet.*	*Feet.*	*Cubic feet.*	*Seconds.*	*Cubic feet.*	*Feet.*
18	710	11,589	16.3	19.8	656,000,000	28,500	23,018	1.99
19	675	11,013	16.3	19.3	659,000,000	28,380	23,221	2.11
20	630	10,865	17.2	19.3	663,000,000	28,260	23,461	2.16
21	708	11,865	15.4	19.4	664,000,000	28,200	23,546	1.98
22	732	12,075	16.5	19.7	666,000,000	28,080	23,718	1.96
23	692	11,700	16.9	22.4	668,000,000	27,960	23,891	2.04
24	670	11,481	17.1	20.1	670,000,000	27,900	24,014	2.09
25	840	11,924	14.2	19.4	672,000,000	27,780	24,190	2.03
26	890	10,672	12.0	18.9	675,000,000	27,720	24,351	2.28
27	980	10,032	10.2	19.9	676,000,000	27,660	24,440	2.44
28	940	9,654	10.4	21.5	678,000,000	27,540	24,619	2.55
29	940	10,636	11.3	20.5	680,000,000	27,480	24,745	2.33
30	1,020	11,510	11.3	17.5	682,000,000	27,360	24,927	2.17
31	1,070	12,340	11.5	17.5	684,000,000	27,300	25,055	2.03
32	1,075	13,795	12.8	20.5	688,000,000	27,180	25,313	1.83
33	2,220	33,090	14.9	34.5	900,000,000	27,120	33,186	1.00
34	2,040	32,330	16.1	34.6	1,145,000,000	27,000	42,407	1.29
35	1,530	30,930	20.2	30.1	1,470,000,000	26,880	54,687	1.78
36	1,800	30,646	17.0	30.6	1,480,000,000	26,820	55,183	1.80
37	2,085	30,760	14.8	32.6	1,490,000,000	26,700	55,805	1.81
38	2,520	32,460	12.9	28.6	1,507,000,000	26,610	56,633	1.74
39	2,710	31,750	11.7	22.6	1,522,000,000	26,490	57,456	1.81
40	1,820	19,130	10.5	20.0	793,000,000	26,370	30,072	1.57
41	1,420	19,040	13.4	20.8	805,000,000	26,250	30,667	1.61
42	2,060	29,820	14.5	20.8	1,110,000,000	26,130	42,480	1.42
43	1,890	28,150	14.9	20.6	1,085,000,000	26,010	41,715	1.48
44	1,390	25,270	18.2	35.1	1,062,000,000	25,920	40,972	1.62
45	1,150	24,335	21.2	37.6	1,070,000,000	25,800	41,473	1.70
46	1,100	24,470	22.2	39.6	1,076,000,000	25,680	41,900	1.71
F	1,180	24,810	20.6	33.7	1,086,000,000	25,620	42,389	1.74
47	1,340	26,330	19.7	32.0	1,092,000,000	25,560	42,723	1.62
48	1,360	26,600	19.6	29.7	1,099,000,000	25,500	43,098	1.62
49	1,550	25,931	16.7	24.2	1,105,000,000	25,380	43,538	1.68
50	1,240	22,726	18.3	21.2	1,113,000,000	25,320	43,957	1.93
51	3,110	31,275	10.1	18.7	1,216,000,000	25,200	48,254	1.54
52	1,160	22,534	19.4	23.7	1,240,000,000	25,140	49,324	2.19
53	4,080	31,930	7.8	23.7	1,262,000,000	25,020	50,440	1.58
54	2,700	35,398	13.1	20.2	1,285,000,000	24,900	51,606	1.46
55	3,260	32,588	10.0	24.7	1,307,000,000	24,780	52,744	1.62
56	2,860	32,780	11.5	33.7	1,327,000,000	24,660	53,812	1.64
57	2,550	34,156	13.3	27.7	1,350,000,000	24,540	55,012	1.61
58	2,410	33,824	14.0	21.3	1,365,000,000	24,480	55,760	1.65
59	1,560	28,190	18.1	22.7	1,375,000,000	24,420	56,306	2.00
60	2,780	38,316	13.8	17.4	1,392,000,000	24,240	57,426	1.50
61	3,120	27,128	8.7	17.1	1,405,000,000	24,150	58,178	2.14
62	3,460	37,011	10.6	19.0	1,440,000,000	24,094	59,776	1.62
63	3,690	39,192	10.6	21.7	1,478,000,000	24,000	61,584	1.57
64	3,770	40,466	10.7	25.2	1,517,000,000	23,880	63,526	1.57
65	3,880	40,180	11.9	27.2	1,537,000,000	23,700	64,607	1.61
66	3,460	41,170	11.9	24.7	1,557,000,000	23,730	65,613	1.59
67	3,660	44,060	12.0	21.5	1,582,000,000	23,580	67,091	1.52
68	3,760	46,020	12.2	21.2	1,602,000,000	23,430	68,374	1.49
69	1,600	31,410	19.6	26.7	1,625,000,000	23,370	69,534	2.21
70	3,240	45,900	14.2	22.7	1,640,000,000	23,280	70,447	1.53
71	3,460	46,140	13.3	21.0	1,655,000,000	23,190	71,367	1.55
H	3,640	46,090	12.7	19.7	1,670,000,000	23,100	72,294	1.57
72	3,980	47,690	12.0	18.7	1,687,000,000	23,100	73,030	1.53
73	4,440	48,460	10.9	18.7	1,707,000,000	23,100	73,896	1.52
74	4,600	40,760	8.9	19.7	1,728,000,000	23,100	74,805	1.84
75	5,230	54,160	10.2	18.7	1,755,000,000	23,100	75,974	1.40

Digitized by Google

TABLE NO. 3.—*Computed channel widths in North Channel.*

Number of cross section.	Discharge per second.	Future velocity.	At mean surface of ebb flow.		
			Future area $=a$.	Assumed future mean depth.	Future width.
	Cubic feet.	*Feet.*	*Sq feet.*	*Feet.*	*Feet.*
B	19,691	2.00	9,846	19.0	518
1	19,835	2.00	9,918	19.0	522
2	19,980	2.00	9,990	19.0	526
3	20,160	2.00	10,080	19.0	531
4	20,407	2.00	10,204	19.0	537
5	20,733	2.00	10,367	19.0	546
6	21,010	2.00	10,505	19.0	553
7	21,332	2.00	10,666	19.0	561
8	21,545	2.00	10,772	19.0	567
9	21,803	2.00	10,902	19.0	574
10	21,960	2.00	10,980	19.0	578
11	22,085	2.00	11,043	19.0	581
12	22,211	2.00	11,106	19.0	585
13	22,360	2.00	11,180	19.0	589
14	22,604	2.00	11,302	19.0	595
15	22,690	2.00	11,345	19.0	597
16	22,769	2.00	11,385	19.0	599
17	22,851	2.00	11,426	19.0	601
18	23,018	2.00	11,509	19.0	606
19	23,221	2.00	11,611	19.0	611
20	23,461	2.00	11,731	19.0	617
21	23,546	2.00	11,773	19.0	619
22	23,718	2.00	11,859	19.0	624
23	23,891	2.00	11,946	19.0	629
24	24,014	2.00	12,007	19.0	632
25	24,190	2.00	12,095	19.0	637
26	24,351	2.00	12,176	19.0	641
27	24,440	2.00	12,220	19.0	643
28	24,619	2.00	12,310	19.0	648
29	24,745	2.00	12,373	19.0	651
30	24,927	2.00	12,464	19.0	656
31	25,055	2.00	12,528	19.0	659
32	25,313	2.00	12,657	19.0	666
33	33,186	2.00	.....	.....	.....
34	42,407	2.00	.....	.....	.....
35	54,687	2.00	.....	.....	.....
36	55,183	2.00	.....	.....	.....
37	55,805	2.00	.....	.....	.....



Digitized by Google

TABLE NO. 3.—*Computed channel widths in North Channel*—Continued.

No. of cross section.	Discharge per second.	Future Velocity.	At mean surface of ebb flow.			Corrected H. W. width H.	Product 2.7×H. P.	Difference a−P.	$\frac{a-P.}{16.3.}$
			Future area=a.	Assumed future mean depth.	Future width.				
	Cubic feet.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	
44	43,790	1.67	26,221	19.0	1,380	2,000	5,400	20,821	1,278
45	44,496	1.68	26,482	19.0	1,394	2,060	5,562	20,920	1,283
46	45,171	1.69	26,730	19.0	1,407	2,130	5,751	20,979	.....
F	45,667	1.70	26,868	19.0	1,414	2,130	5,836	20,977	.....
47	46,166	1.71	27,000	19.0	1,421	2,240	6,048	20,952	.....
48	46,550	1.72	27,064	19.0	1,425	2,280	6,156	20,908	1,282
49	47,084	1.73	27,216	19.0	1,432	2,330	6,291	20,925	1,283
50	47,590	1.74	27,350	19.0	1,440	2,370	6,399	20,951	1,285
51	48,254	1.75	27,574	19.0	1,451	2,430	6,561	21,013	1,289
52	49,324	1.76	28,025	19.0	1,475	2,520	6,804	21,221	1,302
53	50,440	1.77	28,500	19.0	1,500	2,580	6,966	21,534	1,321
54	51,606	1.78	28,998	19.0	1,526	2,650	7,155	21,843	1,340
55	52,744	1.79	29,466	19.0	1,551	2,730	7,371	22,095	1,356
56	53,812	1.80	29,900	19.0	1,574	2,800	7,560	22,340	1,371
57	55,012	1.81	30,393	19.0	1,600	2,870	7,749	22,644	1,389
58	55,760	1.82	30,637	19.0	1,612	2,940	7,938	22,700	1,393
59	56,306	1.83	30,770	19.0	1,620	3,000	8,100	22,670	1,391
60	57,426	1.84	31,210	19.0	1,643	3,070	8,289	22,921	1,406
61	58,178	1.85	31,448	19.0	1,655	3,120	8,424	23,024	1,412
62	59,776	1.86	32,134	19.0	1,691	3,180	8,586	23,548	1,445
63	61,584	1.87	32,960	19.0	1,733	3,250	8,775	24,185	1,482
64	63,526	1.88	33,790	19.0	1,778	3,300	8,910	24,880	1,526
65	64,607	1.89	34,184	19.0	1,800	3,370	9,100	25,084	1,539
66	66,613	1.90	34,533	19.0	1,818	3,440	9,288	25,245	1,549
67	67,091	1.91	35,126	19.0	1,849	3,520	9,504	25,622	1,572
68	68,374	1.92	35,610	19.0	1,874	3,590	9,693	25,917	1,590
69	69,534	1.93	36,030	19.0	1,900	3,650	9,855	26,175	1,602
70	70,447	1.94	36,313	19.0	1,910	3,700	9,990	26,323	1,614
71	71,367	1.95	36,600	19.0	1,926	3,760	10,152	26,448	1,622
H	72,294	1.96	36,882	19.0	1,941	3,800	10,260	26,622	1,633
72	73,030	1.97	37,071	19.0	1,951	3,850	10,395	26,676	1,634
73	73,896	1.98	37,321	19.0	1,964	3,900	10,530	26,791	1,644
74	74,805	1.99	37,590	19.0	1,978	3,950	10,665	26,925	1,652
75	75,974	2.00	37,987	19.0	1,999	4,000	10,800	27,187	1,668

REPORT OF MR. E. A. GIESELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 4, 1891.

CAPTAIN: I have the honor to report as follows on investigations made by me of the subject of the tidal range in rivers and estuaries:

In a report submitted to you on March 9, 1890, I discussed in a general way the problem of the physical conditions governing tidal phenomena in rivers and its practical importance in the planning of works of improvement.

I suggested that an attempt be made to solve this problem by a systematic discussion of the information bearing on it, which has accumulated in the United States Government offices. Such a discussion, I added, even if it did not solve the problem in question, could hardly fail to render some results of value. I believe that this prediction will be found fully verified by the results of a comparative analysis of eleven tidal rivers, which I have the honor herewith to submit.

The data for two of these rivers, the James and the Nansemond, were obtained from Colonel Craighill and Lieutenant Fiebeger, those received from the former officer being especially detailed and explicit. But both these rivers are small, and the tidal conditions on them are not variegated, so that only three individual results could be deduced from them.

The data for the Savannah River were obtained from the records of this office, and seven individual results were deduced from them.

The data for the remaining eight rivers were gathered from publications of the Chief of Engineers, of the Coast and Geodetic Survey, and of various English, German, and French authors. From these, nineteen individual results were deduced.

I desire to add that nearly all of the very considerable amount of work, the final results of which are presented here, has been done by me in my leisure hours. I now proceed to enter upon the subject of the report.

When tidal rivers or estuaries are improved by means of works of restriction it frequently happens, in consequence of such improvement, that the volume of discharge is diminished, not only on account of the superficial area of the river having

Digitized by Google

been decreased, but also on account of a diminution of the range of tide, caused by the greater resistance which the restricted bed offers to the passage of the tidal wave.

In the river proper the evil consequences arising from this loss of volume are generally more than counterbalanced by the beneficial effects of restriction; but in the entrance the decrease of discharge frequently has undesirable consequences. Here restriction may be difficult or entirely impracticable, and if so, then the possibility of maintaining the channel over the outer bar diminishes in the same ratio in which the volume discharged over it is diminished.

Hence it may be said that in many cases the improvement of the river proper and the maintenance of the entrance are in a measure antagonistic to each other. The employment of the means best adapted to achieve the former is apt to be followed by consequences detrimental to the latter. A similar relation exists between the improvement of the entrance by restriction and the maintenance of the channel in the river above, and it is an important part of the task of the engineer to find, in each case, the best possible way of reconciling with each other these diverging interests.

One of the first questions, then, presenting itself in connection with the improvement of the tidal rivers and their entrances is whether or not the proposed works of restriction are apt to exercise an unfavorable influence on the tidal range of the river. While experience and good judgment will *generally* enable the engineer to make a sound forecast in this respect, it can not be said that this can always be done with that certainty which the importance of the subject seems to demand. It is evident that there would be no difficulty about any such forecast if the conditions governing tidal phenomena in rivers and the influence exercised by each of them were known. In the following an attempt has been made to solve this question.

A tidal wave entering a river or an estuary will have its range diminished in moving upward until it is either gradually obliterated or its further progress arrested by an impassable barrier.

This general course of events is, however, subject to modifications in each individual case, so that probably there do not exist two rivers the tidal phenomena of which are precisely the same. In some cases the range of tides decreases rapidly, in others gradually. Again, it often remains unchanged for a long distance, and sometimes it even increases before the final deterioration begins.

The estuaries of the Hudson and of the Delaware, for instance, are entered at Sandy Hook and between the capes, respectively, by tidal waves of about the same range. In the former there is a *decrease* in range of about one-third during the first 40 miles of its upward course while in the latter there is within 20 miles of its mouth an increase in range of about the same amount.

The inference that such and similar differences are caused by the individual features of the river beds in which the tidal waves move appears justified; and it further appears probable that, generally speaking, a most important influence is exercised by the relation between the capacity of the river bed and the amount of service it is called upon to perform. The capacity of the river bed is represented at each point by the cross-sectional area of the river and the amount of service it is called upon to perform by the superficial area of the tidal basin above. The quotient of these two may then be supposed to be a measure of the possibilities of the tidal range above, up to a point where the slope of the river bottom becomes so steep that it exercises a perceptible influence on the further progress of the tidal wave. In a general way this line of argument is sustained by the fact that, where an increase of range takes place, we find comparatively great cross-sectional areas and small extent of tidal basin above, while, *vice versa*, where a very marked decrease of range takes place we find comparatively small cross-sectional areas and great extent of tidal basin above. The Raritan River, in New Jersey, is a fair example of the former case, while the St. Johns River, in Florida, is a striking illustration of the latter.

In order to develop, on the basis outlined above, a mathematical expression for the condition of the river bed required for a propagation of the tidal wave with undiminished range, a comparison was made between the following rivers, for each of which more or less detailed data were available:

(1) Hudson; (2) Delaware; (3) Elbe; (4) Clyde; (5) Raritan; (6) Savannah; (7) Weser; (8) Seine; (9) Nansemond; (10) James; (11) St. Johns.

The high-water cross-sectional area of each river was determined at as many points as the available data would allow, and for each such point the superficial area of the tidal basin above was computed; the former was then divided by the latter, and to avoid cumbrous decimal fractions the quotient was multiplied by 1,000,000. Now, other things being equal, the same coefficient must correspond to a greater loss of range in in the case of a higher range than in the case of the lower range. In order to make possible a comparison between different rivers with different tidal ranges the figures thus obtained were therefore reduced to a common basis by dividing each of them by the tidal range pertaining to it.

Digitized by Google

We designate as follows:
A. = High-water cross-sectional area in square feet at any point.
R. = Mean tidal range in feet at the same point.
S. = Superficial area of tidal basin above such point, expressed in millions of square feet.
We then have for C, the above-described coefficient, at such a place—

$$C = \frac{A}{R\,S} \quad (1)$$

Coefficients found according to this expression were obtained for as many points as possible and means of them were taken for those stretches of the river on which the rate of decrease or increase of range remained the same. From the results thus obtained, which are rendered in the appended tables, it appears that, generally speaking, to the greater coefficient there pertains the greater tendency towards constancy or even increase of tidal range, with this qualification: That the coefficient remaining the same, the approach to constancy or to increase of range will be the closer the greater the cross-sectional area.

A striking verification of this is found in the case of the Savannah River. Besides the mean ranges at the various places there were available 345 rises and falls observed simultaneously at Fort Pulaski and at Fort Oglethorpe. They were grouped according to their height and the following means obtained from them:

Number of observations.	Averages of observed rises and falls at—		Increase or decrease of range per 10 miles and per foot of range.
	Pulaski.	Oglethorpe.	
23	4.66	4.81	+0.046
36	5.50	5.47	0.00
49	6.02	5.91	−0.027
60	6.51	6.31	−0.050
64	7.01	6.70	−0.067
62	7.71	7.16	−0.109
46	8.89	7.94	−0.166

It is seen from this table that for the smallest range, for which C, of course, is greatest, there is an actual gain of range from the lower to the upper point of observation. Next comes a slightly greater range and, consequently, a smaller C, for which there is no change between the two points of observation; and, after that, the loss in tidal range uniformly increases with increasing range and decreasing C.

In order to define clearly the influence exercised by the coefficient and by the cross-sectional area on the tidal range the results rendered on the appended tables were platted on the accompanying diagram, the coefficients, C, being the ordinates, and the corresponding cross-sectional areas in square feet, A, being the abscissa. Whenever an unchanged tidal range pertains to these two the points determined by them have been marked on the diagram by two concentric circles, and, whenever a decrease or an increase of range pertains to them the point determined by them has been marked by a single circle. It will be seen that the various points of no change of range are so located that an equilateral hyperbola introduced on the diagram corresponds with them sufficiently well to warrant the conclusion that it represents approximately the curve of no change of tidal range. This conclusion is further sustained by the fact that the points of decrease and the points of increase are located as they should be, the former outside and the latter inside of the hyperbola.

The axis of ordinates (the coefficients) and a line parallel to the axis of abscissas (the cross-sectional areas) are the asymptotes of this hyperbola, and it now remains to deduce its equation from the general equation of an equilateral hyperbola referred to its asymptotes, which is—

$$x \cdot y = \frac{m^2}{2},$$

in which m is the half axis of the hyperbola. In the diagram this has been made equal to 15 units of the y scale, and we therefore have

$$x \cdot y = 112.5 \text{ or } y = \frac{112.5}{x}$$

Digitized by Google

This would render y in its own scale, if x were expressed in the same, and in order to do this we have to consider the relation between both scales, which is—

Length one y unit = length of 5,000 x units.

Introducing this into our equation, we obtain

$$y = \frac{112.5}{\frac{1}{5{,}000}x} = \frac{562{,}500}{x}$$

Now the asymptotic x is distant from the zero line of the y scale 23 units of the latter. We therefore have

$$\text{Coefficient} = C = y + 23.$$

Substituting this above, and remembering that x and A are identical, we now find

$$C = \frac{562{,}500}{A} + 23.$$

This, in connection with equation (1), renders

$$\frac{A}{R\,S} = \frac{562{,}500}{A} + \qquad (2)$$

or,

$$A^2\,A\,S\,R\,23 = S\,R\,562{,}500.$$

Solving for A, we obtain

$$A = S\,R\,11.5 + \sqrt{S\,R\,562{,}500 + S^2\,R^2\,132.25}$$

or, in a more convenient form,

$$A = S\,R\left(11.5 + \sqrt{\frac{562{,}500}{S\,R} + 132.25}\right) \qquad (3)$$

which is an expression, in terms of the tidal range and of the area of the tidal basin, for the cross-sectional area required for a propagation of the tidal wave with undiminished range.

Solving equation (2) for S, we obtain

$$S = \frac{A^2}{R\,(23\,A + 562{,}500)} \qquad (4)$$

which gives the superficial area of tidal basin above a point lying on a stretch of river on which the tidal wave undergoes no change. It should be borne in mind that while the units of A and of R in these equations are square feet and feet, respectively, the unit of S is 1,000,000 square feet.

The practical bearing of equations (3) and (4) is obvious. By means of them, within certain limits, we can decide the question as to which way the tidal range will be affected by contemplated works of improvement.

The tidal range of Front River, Savannah, for instance, has been considerably diminished by the construction of the Cross Tides Dam; and it has been suggested that the tidal range might be restored by widening and deepening the river bed. The following are the data bearing on this case:

Location.	Old range	Present range.	S.
	Feet.	*Feet.*	
Savannah, Florida and Western Railroad wharves	6.4	6.4	151
Barge office	6.5	6.1	144
Read's mill	6.4	4.8	124
Cross tides	6.4	4.6	.....

Digitized by Google

From equation (3) we find that in order to have a uniform range of 6.4 feet from the Savannah, Florida and Western Railroad wharves up to Cross Tides, as formerly, the following high-water cross-sectioned areas are needed:

	Square feet.
At Savannah, Florida and Western Railroad wharves	36, 936
At barge office	35, 703
At Read's mill	32, 132

That is, an average of nearly 35,000 square feet. When it is considered that at present the high-water cross-sectional area on the same stretch averages about 14,000 square feet, it becomes at once apparent that the object in view can hardly be attained in the way suggested.

The meager data that were available for this discussion are not sufficient to let the results appear as either final or exhaustive. But these results are of such significance as to make desirable the collection of additional data, for the purpose of forming a broader basis of further inquiry into a subject the practical importance of which can not be doubted. It will then probably be possible to find also mathematical expressions for those cases in which the tidal range decreases or increases.

Submitting the above, I am, captain,

Very respectfully, your odedient servant,

E. A. GIESELER,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

---

(1) HUDSON.

Locality.	Distance from mouth.	S millions square feet.	Mean A of stretch.	R.	Mean C of stretch.	Change of range per 10 miles and per foot of range.
	Naut. Miles.		*Sq. feet.*	*Feet.*		
Sandy Hook	0.0	8,326.4	.....	4.70	.....	.....
Battery	14.0	3,726.4	170,000	4.40	14.3	—0.10
Sing Sing	42.0	2,580.4	151,300	3.30	26.6	No change.
Roudout	92.0	1,217.2		3.30		
Tivoli	102.0	940.5	72,000	3.35	26.9	—0.05
Catskill	112.0	717.3		3.20		
Albany	139.5	.....	.....	2.30	.....	.....

(2) DELAWARE.

Cape Henlopen	0.0	20,995	2,430,000	4.5	31.6	±0.14
Egg Island Light	20.0	8,233	548,000	6.0	27.2	No change.
New Castle Range	55.0	1,549	139,200	6.0	26.6	No change.
Big Timber Creek	82.0	495.3	75,000	6.0	30.6	No change.
Five-Mile Point	90.0	316.6	45,300	6.0	34.4	—0.03
Burlington	102.0	167.0	17,600	5.8	36.5	—0.27
Trenton	114.5	.....		4.1		

(3) ELBE.

Schaarhorn	0.0	.....	.....	9.4	.....	.....
Brunsbuettel	27.2	1,982	206,000	9.1	22.1	—0.01
Luebe	55.3	432	65,000	8.9	26.3	—0.31
Hamburg	67.2	208	19,000	6.2	57.0	*—1.10
Elbstorf	85.2	.....		0.0		

(4) CLYDE.

Mouth	0.0	.....	.....	9.7	.....	.....
Dumbarton Castle	5.25	103.6	26,700	10.0	43.7	No change.
Dalmuir Works	10.0	29.8	8,150	10.0	92.0	+0.13
Glasgow Bridge	17.4	.....		11.0		

*Influence of upper slope perceptible.

Digitized by Google

(5) RARITAN.

Locality.	Distance from mouth.	S millions square feet.	Mean A of stretch.	R.	Mean C of stretch.	Change of range per 10 miles and per foot of range.
	Naut. miles.		*Sq. feet.*	*Feet.*		
Sandy Hook	0.0	.....	.....	4.70	.....	.....
South Amboy	12.0	104.7	28,700	4.83	108.6	+0.14
French Landing	17.0	18,9	6,500	5.19	112.4	No change.
New Brunswick	22.5	.....		5.16		

(6) SAVANNAH RIVER AT MEAN RANGE.

Mouth	0.0	.....	.....	7.0	.....	.....
Lower end Long Island	4.6	407	62,250	7.0	27.7	−0.08
Lower end Wreck Channel	11.6	160	14,500	6.6	18.2	−0.62
Read Mill	16.6	124		4.84		
Head of tide	26.4	.....	.....	0.0	.....	.....

(6a) SAVANNAH RIVER AT LOW RANGES.

Lower end Long Island	4.6	407.0	58,200	4.66	36.8	*+0.05
Fort Oglethorpe	11.4	260.0		4.81		
Lower end Long Island	4.6	407.0	60,200	5.5	33.0	No change.
Fort Oglethorpe	11.4	260.0		5.5		
Lower end Long Island	4.6	407.0	60,700	6.02	31.0	−0.03
Fort Oglethorpe	11.4	260.0		5.91		

(6b) SAVANNAH RIVER AT HIGH RANGES.

Lower end Long Island	4.6	407.0	62,950	7.71	25.5	−0.11
Fort Oglethorpe	11.4	260.0		7.16		
Lower end Long Island	4.6	407.0	64,750	8.89	23.2	−0.17
Fort Oglethorpe	11.4	260.0		7.94		

(7) WESER.

Bremerhafen	0.0	641.4	88,100	10.8	22.2	−0.10
Elsfleth	18.5	180.0	19,600	9.0	32.0	*−1.15
Vegesack	27.2	55.5	6,500	3.0	141.0	*−2.28
Hasenbueren	31.8	21.7		0.9		
Bremen	37.3	.....	.....	0.0	.....	.....

(8) SEINE.

Le Havre	0.0	.....	.....	.....	.....	.....
La Risle	10.8	484.0	36,150	14.50	9.7	−0.33
La Malleraye	34.0	293.0		6.40		
Duclair	47.5	210.4	24,000	5.12	38.7	No change.
Rouen	66.4	81.3		5.22		
St. Aubain	80.4	.....	.....	3.21	.....	.....

(9) NANSEMOND.

Newman Point	0.0	129.5	14,300	3.01	129.0	+0.19
Suffolk	12.1	.....		3.78		

*Influence of upper slope perceptible.

Digitized by Google

(10) JAMES RIVER.

Locality.	Distance from mouth.	S millions square feet.	Mean A of stretch.	R.	Mean C of stretch.	Change of range per 10 miles and per foot of range.
Mouth	0.0	144.7	19,500	2.90	85.2	+0.10
Willis Wharf	18.8	33.3	9,450	3.50	137.1	No change.
Brewery	27.9	.....		3.50		

(11) ST. JOHNS.

Mouth	0.0	.....	.....	4.6	.....	.....
Mayport Mills	1.5	4,172.0	57,500	4.3	9.3	—0.68
Jacksonville	19.8	3,540.0	130,000	1.0	(?) 31.0	
Blackpoint	26.2	3,164.0	140,000	.....	(?) 70.0	
San Patricio	41.9	2,028.0	125,000	.....	(?) 160.0	
Tocoi	57.5	941.0	90,000	.....	(?) 250.0	
Palatka	73.2	237.0	.....	.....	.....	
Georgetown	95.8	.....	.....	.....	.....	.....

The coefficients of St. Johns River above Jacksonville are approximate only, because R is not known; their rapid increase, however, can not be doubted and makes it probable that somewhere above Black Point an increase of range takes place.

N 2.

IMPROVEMENT OF SAVANNAH RIVER, GEORGIA.

The Savannah River is formed by the junction of the Tugaloo and Keowee, and flows in a southeasterly direction to the sea.

A detailed description of this river is found in my report of the examination and survey of the portion above Augusta, printed as House Ex. Doc. No. 213, Fifty-first Congress, first session, and in my report of the survey of the river between Augusta and Savannah, dated June 30, 1890, and printed as Appendix O 2, Annual Report of the Chief of Engineers for 1890, pages 1328–1363.

For a special history of past work, see page 1029, Annual Report Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 4 to 5 feet of water, but during the low-water season there are various shoals in the upper portion of the river with low-water depths of not more than about 3 feet. The chief obstructions to navigation consist of sand and gravel bars, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of June 30, 1890, provides for the establishment of a navigable steamboat channel 5 feet deep at ordinary summer low water between the cities of Augusta and Savannah.

Digitized by Google

This is to be accomplished by (1) removing sand and gravel bars; (2) regulating portions of the river, revetting caving banks, and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated in round numbers at $332,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

The first appropriation ever made for the Savannah River was expended on a snag boat built for use upon this river and the Altamaha. This boat began work upon the river on February 17, 1882, and has been employed at intervals since that date, continuous work having been impossible on account of insufficiency of funds. Irregular and inadequate appropriations have prevented the selection of the most suitable seasons for doing work. Then, too, the boat has been tied up for months at a time in a climate where decay is very rapid. As a result numerous and costly repairs have had to be made which would not have been needed had the boat been kept in commission. In 1889 the boat had become rotten and unserviceable and was rebuilt at Abbeville, Ga., under contract with Messrs. M. A. Sweeney & Bro., of Jeffersonville, Ind., and outfitted at Savannah. In all the boat was employed 565 days upon the river between Augusta and Savannah, removing during that time 1 sunken steamboat, 82 piles, 1,224 snags, logs, and stumps, and 1,492 overhanging trees, besides a number of wrecked flats and a number of other minor obstructions. Many of the obstacles were very large and troublesome, and their removal without a suitable snag boat would have been impossible.

In 1883–'85 wing dams, projecting from the South Carolina bank, were built for the improvement of Gardner Bar, opposite the city of Augusta, contracting the low water way from 650 to 350 feet. In the same year shore protection aggregating in length 1,375 feet was put in at eight different points along the city front. Since then contracting works have been constructed at Course Bar, Sand Bar Ferry, and Blue House Bar, situated 2, 4, and 6 miles, respectively, below the city of Augusta.

At Course Bar 7 wing dams have been built, 3 on the right bank and 4 on the left, reducing the low-water way from 650 to 350 feet. At Sand Bar Ferry 5 wing dams were built, 1 on the right bank and 4 on the left, reducing the low-water way from 650 to 400 feet, and in 1889 two additional wing dams were constructed on the right side of the river and the old work was raised and repaired, reducing the low-water width to 350 feet.

At Blue House Bar 7 wing dams were built, 4 on the right bank and 3 on the left, reducing the width of the low-water way from 650 to 400 feet. In 1889, the channel having shifted, a new dam, 580 feet long, was constructed, springing from the right bank, and three additional short spurs were built on the left bank. Portions of the old dams were removed and the resulting low-water channel was 350 feet in width.

These various works have been built of brush fascines, loaded with gravel and riprap stone. In their construction there have been used a total of 17,619.61 cubic yards of brush fascines and 9,424.09 cubic yards of gravel and stone.

All work, with the exception of that done by the snag boat, has been done by contract.

Up to July 1, 1890, the total expenditures for the work, including

Digitized by Google

outstanding liabilities, amounted to $93,480.19, including $2,500 received from other appropriations for use of snag boat.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

Active operations during the fiscal year consisted in the removal of snags, logs, and overhanging trees by the snag-boat *Toccoa*, which left Savannah November 14 to begin work at King Creek.

Operations were carried on until March 12, when they were interrupted by high water, but were resumed on May 12, and finally suspended on June 1, the boat being sent to the Altamaha River.

Work was executed between King Creek and Buzzards Bar, Barney Cut and Ellison Landing, Augusta and Brigham Landing, Little Hell Landing and Blue Bluff, Prescott Reach and Brigham King Creek and Thompson points, improving a total length of river of 43 miles, and removing 343 snags, 11 stumps, and 3,443 overhanging trees; 5 trees were swung to bank and 24 logs cut up on bank.

CONDITION OF WORK JUNE 30, 1891.

The works on the upper portion of the river were damaged to some extent by the freshet that occurred during the month of March of this year.

The water rose at Augusta on March 13 to the height of 36.7 feet on the city gauge, only 1.5 feet lower than the freshet of 1888, which was the highest ever recorded.

An examination recently made under my direction proved the condition of the works of improvement and of the channel to be as follows:

The depth of water along the city wharves at Augusta is ample. The spur dams at Gardner Bar are in good condition, their crests being from 0.5 of a foot to 2 feet above low water; a few small breaks occur in them. The bank protection along the city front is washed out in many places, and during the freshet above referred to the high banks along the city front and just below the city were badly cut into and washed away. The channel across Gardner Bar has improved, the minimum low-water depth being 4.5 feet as against 3 feet in June, 1890.

All the dams at Course Bar are in good condition and rise from 0.5 of a foot to 2 feet above low water. The banks at the shore ends of dams No. 6 and 9 have been cut away some, developing a possible tendency toward flanking these dams. The channel across this bar, which last year was crooked and about 4 feet deep at low water, is now straight, and has a medium depth of 6.5 feet at low water.

Two of the dams at Sand Bar Ferry Bar were seriously damaged by the freshet. Short portions are entirely washed away, and the crests for considerable lengths are broken through and left ragged and irregular. The other three dams at this bar are in good condition. The right bank above low-water line has been cut away considerably.

The depth of the channel across this bar has increased at least 2 feet since the completion of the work in 1889. The channel is now straight and is 6 feet deep at low water.

At Blue House Bar two of the dams on the left bank, viz, Nos. 8 and 9, built in 1889, have again been flanked by the cutting away of the bank. Dam No. 10 of the same series remains in place but has been undermined along its upper edge and tilted upstream. The brush fascines, which, covered with stone, formed the bank protection at the

Digitized by Google

heel of this dam, had been entirely consumed by fire, originating probably from the fires used in clearing the adjacent fields. It is presumable that the same thing had happened to the shore protection at dams No. 8 and No. 9. This supposition offers a probable explanation for the failure of dams No. 8 and No. 9; for the staked fascines being burned away the loosened stones would roll down the bank, leaving it exposed to the action of the strong freshet currents impinging thereon.

The dams on the right-hand side of the channel are uninjured, except dam No. 6, which seems to have a small break or settlement near its shore end.

The channel across Blue House Bar is quite crooked, but offers no difficulty to navigation, and has a mimimum depth of 4.5 feet at low water.

Thus, notwithstanding the damage to the dams occasioned by the recent freshet, they are still in a condition to fulfill their objects, and the improvement caused by them in the depths of the channel over these troublesome bars is marked and encouraging.

At the Port Royal and Augusta Railroad Bridge the left bank of the river is cutting away, and the channel has a tendency to leave the draw by moving over toward the left. The main current of the river now passes to the left of the draw, making it difficult for boats to pass the draw at high water, since they have to approach at an angle with the direction of the current.

The operations of the snag boat *Toccoa* have resulted in a marked improvement of those portions of the river on which she was employed. Many snags which had been dangerous and troublesome to the river steamers and which were frequently struck by them have been removed, and navigation has been rendered easier and safer. The recent freshet has, however, brought more snags into the river, the ultimate removal of which will be necessary.

COMMERCE AND NAVIGATION.

A detailed statement of the sources whence the commerce of this river is derived, of its value during the year, and of the probable effect of the completion of the works of improvement, is given in my report on the survey of the river, dated June 30, 1890, and printed as part of Appendix O 2, Annual Report of the Chief of Engineers for 1890.

Prior to the inauguration of the works of improvement the commerce of the river, especially in the way of through shipments, was unimportant, as the condition of the channel rendered navigation uncertain and unsafe.

The improvement of the river has been accompanied by a steady increase in the volume of river traffic and by a decrease in the rates of freight, both of which are more than commensurate with the expenditures involved. In fact the annual commerce has increased at the rate of $10 for every dollar expended by the United States, and freight rates have been reduced about 20 per cent.

During the calendar year of 1890 there was a decided increase in the upstream through and way freights, but on the other hand a slight falling off in the downstream through freights, which consist principally of cotton and naval stores. This was due to the fact that although the river boats scheduled these articles from Augusta to Savannah, at a rate 20 per cent. less than that of the railroads, the latter issued through bills of lading on shipments from Augusta via Savannah, which was

Digitized by Google

equivalent to a reduction of 5 cents per 100 pounds (or on a bale of cotton a reduction of 25 cents) from their published schedule rate from Augusta to Savannah. This practically equalized the railroad and steamboat freight rates, and a discrimination on the part of the banks at Augusta in favor of the railroads gave the latter a decided advantage over the river boats. But the low freight rates offered by the railroads were due to the existence of the competing line of transportation by way of the river, and the saving in this item may therefore be justly attributed to the fact that the river has been placed in a navigable condition. Notwithstanding the above-mentioned disadvantages, there has on the whole been a marked increase in the volume and value of the river commerce for the calendar year of 1890. There were carried on the river 62,600 tons of freight, valued at $2,429,600, as against 58,000 tons, valued at $2,219,000 for the preceding year.

The exports from the river valley are mainly cotton, naval stores, lumber, and wood, while the imports are fertilizers, camp and mill supplies, cotton ties and bagging, and manufactured articles. Of the resources of the river valley it can reasonably be expected that the annual shipments by water of wood, timber, and naval stores will remain about constant, or at most will not increase by more than 5 or 10 per cent. per year.

The shipment of cotton by river might be much increased by running more boats and, in addition, having proper and adequate facilities for handling and storing the crop. Most of the cotton landings are upon the low banks of the river, where the cotton can not be delivered until the boats are due. With an increased shipment of cotton by boat would come an increased shipment of fertilizers, cotton bagging, ties, etc. During the calendar year of 1890 18,630 bales of cotton were brought to Savannah by Savannah River boats.

Table of rail and river freight rates on cotton, number of boats plying the river, and number of competing steamboat lines, when any, since the year 1885.

Year.	Freight by railroad.	Freight by boat.	Boats plying between Augusta and Savannah.	Competing lines of boats.
	Per bale.	*Per bale.*		
1885	$1.60	1.05	2	2
1886	1.60	1.05	1	None
1887	1.60	1.05	1	None
1888	1.00	.80	4	3
1889	1.25	1.00	2	None
1890	1.25	1.00	3	None

At the beginning of the year 1888 the high railroad rates on freight and the monopoly of the river traffic, which had been enjoyed by one line for 2 years previously, were the factors that caused the building of 3 new boats, the advent of which was the signal for a drop in railroad rates of 60 cents per bale on cotton from Augusta to Savannah. To meet this cut the boats lowered their rates on cotton from $1.05 to 80 cents per bale, even then being 20 per. cent. lower than the reduced rail rate. This sharp competition practically drove from the river the three new boats.

Digitized by Google

Steamers plying on the river, 1890.

Name.	Net tonnage.	Draft when light.	Draft when loaded.	Number of trips in 1890.	From Savannah to—	Freight carried.	Value.
						Tons.	
Ethel	218.61	2.0	5.0	206	Stony Bluff	25,750	$1,545,000
City of Americus	229.35	2.0	4.5	30	Augusta	3,000	180,000
Katie	569.23	3.0	5.0	53	....do	10,360	621,600
Advance	371.40	2.2	5.0	46	....do		
				335		39,110	2,346,000

In addition to the freights carried by the various steamers, the river valley affords logs, hewn and sawed timber, spars, and cord wood. The timber is rafted down the river. A large portion of the cord-wood is lightered to Savannah, while the remainder is used as fuel by the river boats. The hard wood sawed and the staves and shingles split along the river are shipped to Savannah by boat.

During 1890 the river boats plying between Augusta and Savannah carried 39,110 tons of freight, valued at $2,346,600. During the same time it is estimated that 23,500 tons of logs, timber, and cord wood, valued at about $83,000, were rafted or lightered to Savannah and other places along the river. This makes the total shipments of the Savannah River, for the year 1890, 62,600 tons, valued at $2,429,600.

It is almost impossible to obtain accurate statements of the annual commerce on the river, as the figures furnished by the steamer agents are nothing more than estimates, and those who might and ought to be able to collate and furnish satisfactory and true figures seem disinclined to do so. It is believed that the figures herein given, when not specific, are close approximations to the true values.

MISCELLANEOUS.

The work is located in the collection district of Savannah, Ga. Savannah is the nearest port of entry. Amount of duties collected in 1890, $57,542.57. Forts Oglethorpe and Pulaski are the nearest forts, and the nearest light-houses are those upon the river below Savannah.

Since the existing project for improving the Savannah River was adopted one appropriation of $25,000 has been made, and an unexpended balance of $19.91 transferred from a former appropriation.

The total expenditures under the present project up to June 30, 1891, including all outstanding liabilities, were $7,411.24.

It is proposed to expend any available funds and any funds that may become available during the year in the removal of obstructions, in the construction of works of shore protection, and in the improvement of shoals in the river, according to the plan contained in my report of June 30, 1890.

The sum of $75,000 can be advantageously and economically expended during the coming year.

No permanent improvement can be effected, as new obstructions, caused by snags and logs, form during every high-water season. They should, however, become fewer in number each year. From $3,000 to $5,000 will be required for the annual maintenance of the completed work.

Digitized by Google

Money statement.

July 1, 1890, balance unexpended	$19.91
Amount appropriated by act approved September 19, 1890	25,000.00
	25,019.91
June 30, 1891, amount expended during fiscal year	7,411.24
July 1, 1891, balance unexpended	17,608.67
Amount (estimated) required for completion of existing project	307,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	75,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1891.

CAPTAIN: I have the honor to submit the following report of snagging operations on Savannah River, Georgia, for the fiscal year ending June 30, 1891:

Snag work on the Savannah River was inaugurated by the (old) snag boat *Toccoa*, February 17, 1882, and continued at intervals until February 27, 1887. During this period she removed 980 snags, 83 piles, 1,373 overhanging trees, and 3 wrecks. In 1889 she was rebuilt and began work on September 4, 1889, and stopped November 12, 1889, removing 177 snags over 6 inches, 57 snags under 6 inches, 10 stumps, 91 overhanging trees over 6 inches, and 28 overhanging trees under 6 inches; 5 trees were girdled and 5 logs on bank were cut.

The snag boat *Toccoa* was overhauled in October and November, 1890, was provided with a new furnace front, her shear frame was rebuilt, the deck was calked, and the boat painted. She left Savannah November 14 and proceeded to Kings Creek (113¼), removing a few obstructions en route. Operations were continued until March 14, 1891, when continued high water necessitated a stop. Work was resumed May 12, and continued until the snag boat left for the Altamaha River, June 1, 1891.

The records at hand show that the operations from 1882 to 1887 were chiefly beneficial to the river below King's Creek (113¼).

In 1889 the worst obstructions from King's Creek (113¼) to Wring Jaw Point (121½) from boat yard (174½) to Joe Wood's Cut (179½), and from Canoe Gut (194) to Port Royal and Augusta Railroad Bridge (198) were removed. This year (1890-'91) the worst obstructions between Savannah and Augusta (202½) have been removed; but operations have been confined chiefly to the reach from King's Creek (113¼) to Twiggs Bar (188).

Detailed statement of work to date.

	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Explosive used.	Piles removed.	Wrecks removed.
	First class.	Second class.	Third class.		Pulled back.	Cut.						
						Over 8 inches.	Under 8 inches.					
										lbs.		
1882 to 1887 (from report Chief of Engineers, U.S. A. 1888)	150	550	280	.....	295	700	378	.....	.....	.....	83	3
1889 to 1890 (from report Chief of Engineers, U.S. A. 1890)	51	126	57	10	180	736	28	5	5	12	.....	.....
1890-'91	67	189	87	11	194	1,001	2,130	.....	48	1½	.....	.....
Total	268	865	424	21	669	2,437	2,536	5	53	13½	83	3

Digitized by Google

For better comparison of the work of the several parties, the reports have been amended to show first, second, and third class snags. Those of the first class are over 2 feet in diameter at butt; of the second, between 8 inches and 2 feet in diameter; and of the third, under 8 inches in diameter. Trees "pulled back" are also shown, as they require more time than those that are simply cut.

I have changed the record of work previous to September, 1890, by substituting fair proportion of snags of the first, second, and third classes for snags given, and similarly for overhanging trees; the totals for the future will be nearer correct.

Summary of work by months, 1890-'91—Snag boat Toccoa.

Month.	Total days worked.	Days removing obstructions.	Explosive used.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.
				First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.	
1890.			*lbs.*								
November	14	12	.....	13	28	5	4	28	94	130	21
December	25	21	.....	26	82	47	6	30	122	161	3
1891.											
January	27	23	1½	13	68	24	1	76	176	383	.....
February	24	5	.....	1	2	.....	.....	45	103	247	.....
March	12	4	.....	.....	1	.....	.....	5	277	555	.....
May	7	12	.....	14	13	11	.....	10	229	654	24
June	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	120	77	1½	67	189	87	11	194	1,001	2,130	48

Summary of work by localities, 1890-'91.—Snag boat Toccoa.

Locality.	Distance above Savannah.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.	Explosives used.
		First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.		
	Miles.									*lbs.*
Glovers Point	19	.....	.....	.....	.....	.....	30	23	.....	.....
Lady Washington Point	19¾	.....	.....	.....	.....	.....	30	36	.....	.....
Hickory Bend	29	3	2	.....	.....	9	21	155	4	.....
Bay Bush Point	30¾	.....	.....	.....	.....	.....	28	97	.....	.....
Middle Kieffer Point	31¼	.....	.....	.....	.....	.....	10	15	.....	.....
Big Kieffer Point	32¼	.....	.....	.....	.....	.....	20	55	.....	.....
Gaffneys Landing	38	.....	.....	.....	.....	.....	26	10	.....	.....
Bowlmaker Point	41	1	.....	.....	.....	.....	2	4	.....	.....
Trowells Landing	52	4	3	1	.....	.....	.....	.....	.....	.....
Hudson Ferry	68½	1	.....	.....	.....	.....	.....	.....	.....	.....
Jacobs Jump	71	.....	.....	.....	.....	.....	24	18	.....	.....
Poor Robin Lower cut	79	1	.....	.....	.....	.....	.....	.....	.....	.....
Poor Robin Upper cut	81	.....	1	.....	.....	.....	2	2	6	.....
Mosquito Camp	83	1	.....	.....	.....	.....	.....	.....	.....	.....
Thompson Short Point	84	.....	.....	.....	.....	.....	1	3	.....	.....
Cut Finger Cut	89	.....	1	.....	.....	.....	.....	.....	.....	.....
Saucy Boy Point	98	.....	.....	.....	.....	.....	65	117	.....	.....
Mathews Bluff	100½	2	4	1	.....	.....	.....	.....	.....	.....
Cohens Bluff	101	.....	.....	.....	.....	.....	3	7	.....	.....
Dicks Lookout Point	104	.....	1	.....	.....	.....	20	50	.....	.....
Red Bluff Reach	106½	.....	.....	.....	.....	.....	15	70	.....	.....
Sawyers Cut	108½	.....	1	.....	.....	.....	.....	.....	.....	.....
Swift Creek	112	.....	.....	.....	.....	.....	5	58	.....	.....
King Creek (below)	113	2	5	.....	4	.....	8	10	5	.....
King Creek (upper)	115	4	13	16	.....	13	27	42	30	.....
Wring Jaw Point	121¼	3	2	.....	.....	.....	.....	.....	.....	.....
White Woman Point	123	3	1	.....	.....	1	1	.....	.....	.....
Prescott Reach	128½	.....	.....	.....	.....	.....	15	27	.....	.....
Sweetwater Point	132	.....	.....	.....	.....	.....	1	1	.....	.....
Little Hell Landing	133½	.....	2	.....	.....	7	10	40	.....	.....
Confederate Obstruction	137	1	.....	.....	.....	.....	.....	.....	.....	.....
Jack of Clubs Point	138	.....	1	.....	.....	.....	.....	.....	.....	.....
Robinson Round	139	.....	.....	.....	.....	.....	101	147	.....	.....

Digitized by Google

Summary of work by localities, 1890–'91.—Snag boat Toccoa—Continued.

Locality.	Distance above Savannah.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.	Explosives used.
		First class.	Second class.	Third class.		Pulled back.	Cut.			
							Over 8 inches.	Under 8 inches.		
	Miles.									*lbs.*
High-Low-Jack-and-the-Game Point	140	.....	1	.....	.....	.....	.....	.....	.....	.....
Rattlesnake Camp	141	.....	.....	.....	.....	.....	7	3	.....	.....
Deep Cut	143	.....	.....	.....	.....	5	192	448	.....	.....
Blue Bluff	150½	.....	.....	.....	.....	38	54	114	.....	.....
Cox Point	154	.....	1	2	.....	7	16	34	.....	.....
Haynes Cut	158	1	3	5	.....	5	44	72	.....	.....
Shell Bluff	163	.....	.....	.....	.....	7	16	76	.....	.....
Shaw's High House	168	2	3	2	.....	.....	4	5	.....	.....
Buzzard Bar	169	9	18	.....	1	17	32	52	.....	.....
Greys Point	169½	3	14	11	.....	.....	1	.....	.....	.....
Holmes Cut	170	.....	.....	.....	.....	3	5	3	.....	.....
Lower Silver Bluff	174	2	6	8	.....	.....	.....	.....	.....	.....
Boat Yard	174½	9	23	8	.....	7	22	19	3	.....
Golphin Bar	175½	2	4	.....	.....	2	7	10	.....	.....
Canoe Reach	177	.....	3	2	.....	2	9	49	.....	.....
Joe Woods Cut	179½	1	6	1	3	.....	.....	.....	.....	.....
Barneys Cut	180	4	10	9	2	.....	.....	.....	.....	.....
Hungry Swamp	181	2	2	1	.....	.....	.....	.....	.....	.....
Ten Mile Bar	183	.....	5	4	.....	36	71	149	.....	.....
Dunbar Landing	185	1	1	.....	1	2	10	4	.....	1½
Half Guineau Bar	186½	1	19	9	.....	13	8	6	.....	.....
Twiggs Bar	188	4	17	6	.....	16	18	53	.....	.....
Mason Landing	191	.....	13	1	.....	4	20	46	.....	.....
Blue House Bar	197	.....	3	.....	.....	.....	.....	.....	.....	.....
Total	.....	67	189	87	11	194	1,001	2,130	48	1½

The river is in better condition now than it ever has been. King Creek (113¼) gives no trouble, and the upper point, having been cleared of trees, is gradually washing away and improving the entrace.

There is still a large number of snags that should be removed, but the most dangerous are gone. I believe two more seasons' work will clear the river, and after that one or two months' work each year will keep it in good condition.

One snag that was removed from Golphin Bar (175½) on January 30, 1891, is worthy of mention, as it is the largest we ever handled. It was a cypress with 3 limbs, each 26 inches in diameter, and they ranged from 30 to 50 feet in length. It lay in the bight, quartering downstream. The three limbs were cut and laid on deck, the tree swung round and picked up. There were 3 chains, all at the roots, but they projected under the bow and the snag could not be lifted clear of the water. The river was 9 feet above low water, and as the wheel was lifted out of water a line was run across the river and the snag deposited on the bar. At the top, where the limbs were cut, the tree was 4 feet in diameter; at the butt, 6 feet, and it measured 14 feet across the roots. From the top to the butt it was 50 feet long, and thence to the roots 10 feet. Taking 75 pounds as the weight of a cubic foot of water-soaked cypress, as determined by several trials, the snag, without allowing for the dirt on the roots and the limbs, would weigh 72 tons.

The Port Royal and Augusta Railroad Bridge (198) has been complained of on account of its maneuvering apparatus not being capable in a high wind. The steamer *Advance* met with an accident there, due to this defect.

There have been no accidents to steamers or other craft navigating the Savannah River due to snags.

The snag boat *Toccoa* has been in charge of Capt. R. Johnson.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

Digitized by Google

N 3.

IMPROVEMENT OF DARIEN HARBOR, GEORGIA.

About 12 miles above the town of Darien, the Altamaha River divides into several branches. The northerly main branch forms the Darien River. That portion of Darien River between Darien and Doboy Sound is known as Darien Harbor.

Operations for improving this harbor have been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge, dated January 30, 1885, and printed as Appendix N 16, Annual Report of the Chief of Engineers for 1885.

ORIGINAL CONDITION.

Darien Harbor is at seven points, and covering a total distance of 9.7 miles, more or less obstructed by shoals with minimum low-water depths on them of from 6.3 to 10.6 feet. The reaches between these shoals have nowhere less than 12 feet depth at mean low water. The mean rise and fall of tide in the river is about 6.5 feet.

PLAN OF IMPROVEMENT.

The plan of improvement contemplates the establishment of a navigable channel between Darien and Doboy with a minimum low-water depth of 12 feet. This is to be accomplished by dredging to a minimum depth of 12.5 feet, and by the construction of wing dams at five of the shoals for maintaining the depth of the improved channel.

The estimated cost of the improvement is $170,000.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

Five of the shoals in Darien Harbor were temporarily improved by dredging in 1879, by means of an appropriation of $8,000 made by act of Congress approved June 18, 1878.

No work has been done under the present project.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

A contract for dredging was executed on May 5, 1891, with P. Sanford Ross, he being the lowest bidder. Work was begun on June 11 at Shoal No. 3, below Pico Cut, and continued during the month. There were removed 13,194.6 cubic yards.

CONDITION OF WORK JUNE 30, 1891.

No change from the original condition has taken place except on Shoal No. 3, where the small amount of dredging has been done.

COMMERCE AND NAVIGATION.

The commerce of Darien is entirely dependent upon water carriage. It consists principally of shipments of lumber, timber, naval stores, and rice, which are brought down the Altamaha from the region bordering that river and its tributaries. But little cotton seeks an outlet at this port. During the year 1890 the total trade amounted to 121,908 tons, valued at $1,385,751; the freight on which was $579,208.

Digitized by Google

The outlet of Darien Harbor is by way of Doboy and Doboy Bar, but the shoaling of the latter renders the entrance of deep-draft vessels impossible, and much of the timber that would otherwise be shipped from Darien is now rafted to Sapelo and St. Simons, at an increased cost of about 25 cents per 1,000 feet. These shipments, amounting annually to about 20,000,000 feet, are not included in the Darien exports, although it all passes through the harbor. In the event of a ship channel being opened between Darien and Sapelo, thus giving a deep-water entrance to the harbor, the commerce of Darien will be greatly increased.

	Amount.	Tons.	Value.
Naval stores ..... bbls..	24,660	5,473	$160,050
Lumber and timber ..... feet..	79,982,087	116,185	1,125,101
Rice ..... bushels..	100,000	250	100,000
Total	.....	121,908	1,385,751

There is also a large number of small sailing craft carrying rice, fish, vegetables, etc., plying on the inland waters around Darien, and on the inland route there are 2 steamers per week to Savannah and 6 steamers per week to Brunswick.

MISCELLANEOUS.

The work is situated in the collection district of Brunswick, Ga. Darien is the nearest port of entry. Duties collected in 1890, none. Sapelo Light is the nearest light-house and Forts Oglethorpe and Pulaski are the nearest forts.

By act of Congress approved June 18, 1878, an appropriation of $8,000 was made for this work.

Since the existing project for the improvement of Darien Harbor was adopted in 1885, one appropriation of $25,000 has been made for the work.

It is proposed to expend the funds on hand and any that may become available during the year in the removal of the shoals by dredging and in the construction of works of contraction, in accordance with the existing project.

The sum of $50,000 can be economically and advantageously expended during the coming year.

Money statement.

Amount appropriated by act approved September 19, 1890		$25,000,00
June 30, 1891, amount expended during fiscal year		1,835,73
July 1, 1891, balance unexpended		23,164,27
July 1, 1881, outstanding liabilities	$3,034,76	
July 1, 1891, amount covered by uncompleted contracts	16,965.24	
		20,000.00
July 1, 1891, balance available		3,164.27
Amount (estimated) required for completion of existing project		145,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Digitized by Google

Abstract of proposals for dredging in Darien Harbor, Brunswick Harbor, and Jekyl Creek, Georgia, opened on April 20, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price and locality.			Amounts.			Total.
		Brunswick Harbor.	Darien Harbor.	Jekyl Creek.	Brunswick Harbor for estimated 45,000 cubic yards.	Darien Harbor for estimated 100,000 cubic yards.	Jekyl Creek for estimated 10,000 cubic yards.	
1	P. Sanford Ross, Jersey City, N. J.*	$0.24½	$0.23	$0.24	$11,025	$23,000	$2,400	$36,425
2	Savannah Dredging Company, Savannah, Ga.	.27	.27	.23½	12,150	27,000	2,350	41,500

Amount available for Darien Harbor, about $20,000.

* Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable service.

Arrivals and clearances of vessels at Darien, Georgia, from January 1, 1875, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.			Greatest draft.
				American vessels.			Foreign vessels.						
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	
													Ft.
1875	77	28,053	647	....	.....	.....	92	47,600	1,198	169	75,663	1,845	22
1876	65	23,105	611	.....	.....	.....	124	70,368	1,897	189	93,473	2,508	21
1877	104	24,827	1,257	3	674	22	99	50,913	1,231	206	106,414	2,510	20
1878	61	29,264	641	2	1,051	20	126	60,109	1,628	189	90,424	2,289	20
1879	58	23,275	487	3	1,199	25	115	57,710	1,407	176	82,184	1,919	19½
1880	66	21,539	489	1	688	13	134	68,072	1,608	201	90,270	2,140	19½
1881	101	40,619	849	3	1,220	29	162	84,457	1,991	166	126,295	2,869	19½
1882	117	48,208	999	1	453	9	90	51,421	1,155	208	100,082	2,163	19
1883	95	38,173	815	.....	.....	.....	93	49,790	1,135	188	87,963	1,950	19
1884	81	34,412	714	2	606	16	92	50,178	1,133	175	85,193	1,863	19
1885	78	27,763	691	2	652	16	80	42,587	975	160	71,002	1,673	18½
1886	108	44,389	852	.....	.....	.....	42	20,772	483	150	65,161	1,335	19
1887	127	57,035	1,059	5	2,349	45	26	13,023	298	158	72,407	1,402	....
1888	185	77,645	1,558	1	402	9	22	13,423	273	208	91,470	1,840	18½
1889	145	69,763	1,341	7	4,349	62	61	19,837	453	213	93,949	1,856	18½
1890	169	58,058	1,158	5	1,964	41	28	1,086	308	202	61,108	1,507	18½

CLEARED.

1875	22	12,214	328	11	4,055	97	104	55,759	1,372	137	72,028	1,797	22
1876	39	9,300	270	4	1,553	32	180	87,489	2,263	223	98,342	2,565	21
1877	44	13,209	314	4	842	21	169	92,795	2,154	217	106,846	2,489	20
1878	28	7,842	181	6	3,009	62	149	83,385	1,947	183	94,236	2,190	20
1879	40	14,052	301	7	2,765	57	125	65,433	1,538	172	82,250	1,896	19½
1880	55	17,076	393	7	3,580	72	168	84,172	2,016	230	104,837	2,481	19½
1881	80	28,492	617	8	3,120	70	184	95,353	2,164	272	126,965	2,851	19½
1882	93	34,098	709	6	1,962	46	115	63,525	1,434	214	99,585	2,189	19
1883	66	25,019	510	9	3,533	72	108	56,411	1,340	183	84,963	1,931	19
1884	59	20,637	457	11	3,977	85	119	66,337	1,478	189	90,951	2,020	19
1885	46	16,649	339	8	3,354	62	98	52,742	1,198	152	72,745	1,599	18½
1886	93	38,295	719	10	3,687	80	50	24,376	564	153	66,358	1,363	19
1887	126	55,944	1,016	12	1,144	17	16	8,612	189	144	65,700	1,222	....
1888	155	64,749	1,318	2	538	15	36	23,742	453	193	89,029	1,786	19
1889	155	63,347	2,091	6	4,333	66	46	26,488	528	207	94,168	2,685	....
1890	171	58,810	1,174	3	972	28	31	15,569	336	205	75,351	1,533	....

Digitized by Google

Timber shipments from port of Darien, Georgia, from January 1, 1875, to December 31, 1890.

Year.	Foreign.		Coastwise.		Total.	
	Superficial feet.	Value.	Superficial feet.	Value.	Superficial feet.	Value.
1875	41,447,024	$557,524	10,992,600	$181,377.00	52,439,624	$738,901.00
1876	60,762,000	735,099	8,370,000	138,105.00	69,132,000	873,204.00
1877	64,378,000	776,856	11,888,100	196,153.65	76,266,100	973,009.65
1878	59,697,124	716,365	7,057,800	116,453.70	66,754,924	832,818.70
1879	47,217,818	566,613	12,646,800	208,672.20	59,804,618	775,285.20
1880	74,612,520	895,350	15,368,500	253,578.60	89,981,020	1,148,928.60
1881	65,420,876	785,050	25,642,800	423,106.20	91,063,676	1,208,156.20
1882	36,639,379	439,672	30,688,200	506,355.30	67,327,579	946,027.30
1883	42,385,000	508,620	22,517,100	371,532.15	64,902,100	880,152.15
1884	50,656,000	607,872	18,573,300	306,459.45	69,229,300	914,331.45
1885	40,101,000	501,262	14,984,100	247,937.65	55,085,100	749,199.65
1886	19,960,000	219,500	24,465,000	661,440.00	54,425,000	870,940.00
1887	12,023,611	138,476	50,349,600	912,220.00	62,373,211	1,056,960.00
1888	17,975,371	215,705	65,998,200	1,121,960.00	83,975,571	1,337,665.00
1889	20,772,265	237,652	50,667,660	760,144.00	71,449,865	997,816.00
1890	10,962,017	140,746	68,223,683	949,762.00	79,185,700	1,090,508.00

Commerce.

Year.	Value of exports.	Value of imports.	Total collections.
1880	$1,621,904	$5,600	$11,806.72
1881	1,137,490	3,356	18,980.02
1882	1,073,008	1,025	11,254.19
1883	969,834	2,334	11,067.37
1884	1,038,185	11	9,688.20
1885	860,500	.....	2,359.01
1886	1,037,330	.....	.....
1887	1,221,000	.....	.....
1888	2,100,000	2,600	964.13
1889	997,816	None	None
1890	140,746	None	None

THOMAS B. BOWEN,
Deputy Collector, Darien, Georgia.

N 4.

IMPROVEMENT OF ALTAMAHA RIVER, GEORGIA.

The Altamaha River is formed by the junction of the Oconee and Ocmulgee rivers, in the southeastern part of Georgia, and flows in a southeasterly direction to the sea.

A detailed description of this river is given in my report of a survey, dated June 12, 1890, which is printed as part of Appendix 0 5, Annual Report of the Chief of Engineers for 1890, pp. 1372–1386.

For a special history of past work see page 1038, Annual Report of the Chief of Engineers for 1888, and the annual reports of the same officer since that date.

ORIGINAL CONDITION.

The chief obstruction to the navigation of the Altamaha River consisted in rock ledges, sand bars, overhanging trees, snags, and sunken logs. The rock ledges were confined to the upper portion of the stream, while the other obstructions were found throughout its entire course. The low-water depths at some points did not exceed 1 foot.

Digitized by Google

PLAN OF IMPROVEMENT.

The plan of improvement outlined in my report of June 12, 1890, provides for the establishment of a navigable steamboat channel 3 feet deep at ordinary summer low water between the junction of the Oconee and Ocmulgee rivers and the town of Darien.

This is to be accomplished by (1) removing rock shoals and sand bars; (2) building deflecting dikes and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream; (4) revetting caving banks.

The cost of the improvement is estimated, in round numbers, at $129,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

The first appropriation ever made for the Altamaha ($5,000) was expended on a snag boat, which was built for use upon this river and the Savannah. This boat began to work upon the river on October 1, 1883, and has been employed at intervals since that date, regular work having been impossible on account of the insufficiency of funds. She was thoroughly repaired in 1889.

Operations have been carried on between Darien and the junction of the Oconee and Ocmulgee rivers. There have been removed in all 2 piles, 1,106 snags and logs, and 2,158 overhanging trees; 14 logs were cut up on bank and 5 trees were deadened.

In 1883 channels 100 feet in width and 4 feet in depth at ordinary low water were opened through the rock ledges at Town Bluff and Piney Bluff by the removal of 319 and 1,480 cubic yards of rock at those points, respectively.

In 1884–'85 a training wall was built at Beard's Bluff for the improvement of a shoal at that locality, and shore protection was constructed for the protection of caving banks. In the execution of this work 811.2 cubic yards of stone, 428.44 cubic yards of gravel, and 3,545.38 yards of brush fascines were used.

All work, with the exception of that done by the snag boat, has been done by contract.

Up to July 1, 1890, the total expenditures for this work, including outstanding liabilities, amounted to $64,776.59.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

Active operations during the year were confined to those of the snag boat *Toccoa*, which began operations on June 2 and continued during the month, removing the most troublesome snags and overhanging trees from the river's mouth to Cypress Nursery, a distance of 85½ miles from Darien. There were removed 150 snags and stumps and 466 overhanging trees. In addition, 4 trees were pulled back and 2 logs cut up on bank.

CONDITION OF WORK JUNE 30, 1891.

A detailed description of the condition of the river, containing a statement of the localities needing improvement, is given in my report of June 12, 1890. The river is now in a better condition than it has ever before been. The obstructions need to be removed from the upper

Digitized by Google

portion of the river and additional works are necessary at Beard's Bluff. These will be constructed when the stage of river will permit.

COMMERCE AND NAVIGATION.

The commerce passing over the Altamaha River is derived not only from the region bordering it but also from the country bordering its tributaries, the Ocmulgee and the Oconee rivers.

About one-half of the counties bordering the Altamaha River is wholly dependent upon the river for transportation, while the remainder is served in part by two railroads, the East Tennessee, Virginia and Georgia, running approximately parallel to the river on its southern side, at an average distance of about 15 miles from it, and the Savannah, Florida and Western, crossing the river at Doctortown at about right angles to its general direction. The territory dependent upon the river for the transportation of its prodduce and supplies is composed of one-third of the counties of Appling, Wayne, Glynn, and all of Tatnall and McIntosh.

An immense business in lumber and naval stores has been developed in the region adjacent to the Altamaha and its two tributaries, and this business is entirely dependent for cheap and remunerative carriage to the port of Brunswick, upon these rivers. The quantities shipped increase yearly, and those interested in the naval-stores business believe that this increase will continue for 14 or 15 years to come; and then, the activity of the lumber and naval stores business being checked, attention will be devoted to the raising of cotton and grain on the cleared land, and these products will seek a market by the way of the river, which will in all cases offer the cheapest and, in many instances, the only means of transportation.

The following boats were engaged in traffic on this river during the past fiscal year:

Name.	Registered tonnage.	Draft.		Number of trips during year.	Connect with.
		Light.	Loaded.		
		Inches.	*Feet.*		
William M. Wadley	204	20	4	109	Railroad at Doctortown, Ga.
Swan	360	18	3½	39	

These steamers discharged their freight at Doctortown, whence it was taken by rail to Savannah, and the following table shows the composition and value of freight brought to and carried from that town:

Article.	Quantity.	Tons.	Value.
Rosin ..... bbls..	40,212	9,048	$100,530
Spirits turpentine ..... do...	8,019	1,684	148,351
Cotton ..... bales..	2,110	527	84,400
Guano ..... tons..	983	983	29,490
Miscellaneous ..... do...	5,373	5,373	537,300
Total		17,615	900,071

From the Oconee and Ocmulgee rivers nearly all of the lumber cut has gone through to the coast over the Altamaha. It is believed that 70,000,000 feet, or 169,400 tons, valued at $630,000, is a conservative esti-

Digitized by Google

mate of this business for the past year. This, added to the steamboat commerce, gives the total tonnage of the river for the past twelve months as 187,015 tons, valued at $1,530,071.

The Savannah, Americus and Montgomery Railway had during 1889 4 steamers running from Abbeville, on the Ocmulgee, through to the coast, discharging their freight at Brunswick. During that year, up to October, they carried over that route 21,365 tons of rosin, turpentine, cotton, hay, oats, corn, flour, railroad iron, guano, and general merchandise. This was valued at $1,268,000. The line was discontinued in the month named, when the extension of the road to Savannah was completed.

When the Oconee and Ocmulgee rivers are opened to navigation as far as Milledgeville and Macon, respectively, and a low-water channel 3 feet in depth is secured on all three rivers, the commerce of the Altamaha will undoubtedly be largely increased. The improvement of the two first-named rivers is delayed on account of the presence of a railroad bridge below Milledgeville on the Oconee and a highway and railroad bridges above Hawkinsville on the Ocmulgee. It is impossible to give a close estimate of the increase of business that would follow the alteration of all of these bridges and the completion of the works of improvement, but it is safe to say that it would increase nearly 200 per cent.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1890, $5,748. Sapelo Light is the nearest light-house and Forts Oglethorpe and Pulaski are the nearest forts.

Since the present project for improving the Altamaha River was adopted, one appropriation of $15,000 has been made for the work and an unexpended balance of $223.41 transferred from a former appropriation.

The total expenditures under the present project to June 30, 1891, including all outstanding liabilities, were $2,446.79.

It is proposed to expend the funds on hand and any that may become available during the present fiscal year in the removal of obstructions and in the improvement of the shoal places in the river, according to the revised project of 1890.

The sum of $45,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every freshet stage. They should, however, diminish in number from year to year. From $3,000 to $5,000 will be required for the annual maintenance of the completed work.

Money statement.

July 1, 1890, balance unexpended	$223.41
Amount appropriated by act approved September 19, 1890	15,000.00
	15,223.41
June 30, 1891, amount expended during fiscal year	1,946.79
July 1, 1891, balance unexpended	13,276.62
July 1, 1891, outstanding liabilities	500.00
July 1, 1891, balance available	12,776.62
Amount (estimated) required for completion of existing project	114,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	45,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Digitized by Google

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1891.

CAPTAIN: I have the honor to submit the following report of snagging operations on the Altamaha River, Georgia, for the fiscal year ending June 30, 1891:

Snag work on this river was inaugurated by the (old) snag boat *Toccoa* October 1, 1883, and, assisted by steam hoister, continued at intervals since then until January 14, 1888. During this period there were removed 936 snags, 2 piles, and 1,849 overhanging trees; 5 trees were also girdled.

In 1889, the snag boat was rebuilt. Commenced work November 13, 1889, and stopped January 9, 1890, removing 137 snags over 6 inches in diameter, 33 snags under 6 inches, 5 stumps, 137 overhanging trees over 6 inches, 172 overhanging trees under 6 inches, and 10 logs on bank were cut.

Operations were resumed June 2, 1891, and the boat is now at work. The records at hand show that from 1883 to 1887 operations were principally confined to the river below Ohoopee White Bluff (87½+).

In 1890, the worst obstructions were removed from the entire length of river, beginning at Sansavilla (22) and ending at the Forks (127). This year, 1890–'91, the worst obstructions have been as far up as Cypress Nursery (81+½). Carter Bight (81) has been a troublesome point on account of a rock shoal, compelling boats to pass on the bar side. I found that there was a channel next the bank and have had it cleared of snags.

Detailed statement of work done to date.

	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Explosive used.	Piles removed.	Rock removed from shoal.	Linear feet of jetty.
	First class.	Second class.	Third class.		Pulled back.	Cut.							
						Over 8 inches.	Under 8 inches.						
										Lbs.		*Cu. yds*	
1883 to 1888 (from U. S. Chief of Engineers' Report 1889)	136	500	300	....	849	700	300	5	....	....	2	1,799	1,744.2
1888–'90 (from U. S. Chief of Engineers' Report, 1890)	30	107	33	....	57	80	172	....	....	15	....	.....	.....
1890–'91	10	134	46	6	4	206	260	....	2	....	....	.....	.....
Total	176	741	379	6	910	986	732	5	2	15	2	1,799	1,744.2

For better comparison of the work of the several parties, the reports have been amended to show first, second, and third class snags. Those of the first class are more than 2 feet in diameter at the butt; those of the second, between 8 inches and 2 feet in diameter; and those of the third, less than 8 inches in diameter. All trees and logs under water are considered as snags. The trees pulled back are also shown, as it requires more time to pull a tree than it does to simply cut one.

I have changed the record of work previous to this year by substituting fair proportions of snags of the first, second, and third classes for snags given, and similarly for overhanging trees, so that the totals for the future will be nearer correct.

Digitized by Google

Summary of work by months, 1890–'91, snag boat Toccoa.

Month.	Total days worked.	Days' removing obstructions.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.
			First class.	Second class.	Third class.		Pulled back.	Cut.		
								Over 8 inches.	Under 8 inches.	
June, 1891	24	18	10	134	46	6	4	206	260	2

Locality.	Distance above Couper Bar.	Snags.			Stumps.	Overhanging trees.			Logs on bank cut.
		First class.	Second class.	Third class.		Pulled back.	Cut.		
							Over 8 inches.	Under 8 inches.	
Phin Holloway	30½		1						
Bugs Suck	33		4				21	21	
Steamboat Cut	36		1						
Second Water Oak Round	38	2	1				45	26	
Buggs Bluff	51		2	1			2		
Hughes Landing	60	3	24	1			13	3	2
Beards Bluff	65½	3	11	14		1	4		
Stooping Gum Cut	71	2	7			3	37	35	
Metlocks Water Road	73½		2				45	90	
Carter Bight	81		63	22	5		27	69	
Cypress Nursery	81½		8	2					
Chaplin Lake	82½		10	6	1		12	16	
Total		10	134	46	6	4	206	260	2

The river is now in better condition than it ever has been, and I believe that all dangerous obstructions will be removed upon completion of this trip. There will be two months' work necessary each year to keep the river in good condition.

The boats plying this river have had no trouble at Beard Bluff (65 + ½) during past year, as the river has kept above low water. Contraction works, however, are necessary.

The snag boat *Ocmulgee* had to lower her shear legs to pass under the Savannah, Florida and Western Railway bridge at Doctortown. This bridge should be provided with a draw span, but as the snag boats are the only ones that are subjected to trouble in passing this bridge, and as they pass there but twice a year, I do not believe it is absolutely necessary to do this at present.

The steamer *Wadley* struck a snag below Beard Bluff (65 + ½) last summer, and had to be sent to Savannah for repairs. The pilot was out of the channel. No other accidents have been reported. All distances are above Couper Bar (0).

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 5.

IMPROVEMENT OF OCONEE RIVER, GEORGIA.

The Oconee River rises in the northeastern part of Georgia, flows in a southeasterly direction, and unites with the Ocmulgee to form the Altamaha. A detailed description of this river is given in my report of the preliminary examination and survey, printed as House Ex. Doc., No. 211, Fifty-first Congress, first session. For a special history of past work, see page 1253, Annual Report of the Chief of Engineers for 1889.

Digitized by Google

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 3 to 4 feet, but during the low-water season there are various shoals with low-water depths of not more than 2 feet. The chief obstructions to navigation consists of sand bars, rock shoals, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of February 5, 1890, provides for the establishment of a navigable steamboat channel 3 feet deep at ordinary summer low water from Milledgeville to the river's mouth.

This is to be accomplished by (1) removing rafts, rock shoals, and sand bars; (2) enlarging portions of the river, revetting caving banks, and closing incipient cut-offs; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated at $171,000 provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JUNE 30, 1890.

Between 1812 and 1842 about $45,000 were expended by the State of Georgia in the improvement of this river, and between 1874 and 1875 about $8,575 were expended by the Oconee Steamboat Company between Dublin and the Central Bridge, a distance of 28 miles. Operations under the project adopted in 1878 were begun in 1878, and have been carried on at irregular intervals, as the available funds allowed, ever since. A specific appropriation of $1,500 for improving the section of the river between Skull Shoals and the Georgia Railroad Bridge was expended so as to give a least depth in that reach of 20 inches at extreme low water.

In all there have been removed from the river 4,154 snags and logs, 17,649 overhanging trees, and 487 cubic yards of rock. Some small brush jetties have been built, 539 trees have been deadened, and 26 logs cut up on bank.

Up to July 1, 1890, the total expenditures for the work, including outstanding liabilities, amounted to $44,822.18.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

During the months of October and November the boats required for use on this river were repaired and painted.

Active operations during the year consisted in the removal of snags, logs, and overhanging trees, in the construction of a closing dam of stone at Fish Trap Cut, and works of construction in the form of pile and brush dams at Old Boat Yard.

Snagging operations, beginning November 27 and ending May 29, were carried on by the snagboat *Ocmulgee* between Centre Cut and Dublin, partially improving a total length of river of 46¾ miles, and removing 893 snags, 200 stumps, 146 overhanging trees, and 42 logs. Operations were much interferred with by high water in the months of February, March, and April. During this time the boat was employed in constructing the closing dam at Fish Trap Cut. There were quarried

Digitized by Google

and placed in this dam 600 cubic yards of stone. From March 12 to March 24 no work could be done on account of the freshet.

The contracting works at Old Boat Yard were begun in February, but owing to the freshet were necessarily suspended in March.

A working lighter was built, 19 piles were driven, and 11 brush mattresses were sunk, forming an apron course for two dams, 18 feet wide and 260 and 70 feet long, respectively.

The work of building a new snagboat, the *Satilla*, for joint use on this river and on the Ocmulgee, was begun in March at Abbeville, Ga., under contract with M. A. Sweeney & Bro., of Jeffersonville, Ind.

CONDITION OF WORK JUNE 30, 1891.

The river is in a fair condition where work has been done, but still needs much attention, especially the upper portion. Above Dublin the Central Railroad Bridge and a raft obstruct navigation. The work already done has been of great benefit to navigation, boats now running at stages of water from 2 to 3 feet lower than before the improvements were begun.

A detailed description of the condition of the river is given in my report of February 5, 1890, printed on pages 1432–1454, Annual Report of the Chief of Engineers for 1890. No material change has taken place since then, except at Old Boat Yard, Fish Trap Cut, and Sweeney Cut.

An examination of the work of improvement begun at Old Boat Yard was made June 11. From the middle of February to the 1st of May the river was at freshet stage, and about March 18 reached a height of 22 or 23 feet, equal to the greatest height previously recorded.

The effect of this freshet at Old Boat Yard was to cut away the right bank of the river some 20 or 25 feet, carrying with it three of the piles driven when the work was begun. All other piles and the apron courses of dams Nos. 7 and 8 are uninjured. This work is not sufficiently advanced to have any appreciable effect on the channel across the bar. There is, however, a least channel depth of 3.3 feet at low water where the depth did not exceed 2.6 feet in 1889.

The work at Fish Trap Cut is in good condition.

Sweeney Cut, across the bight, which is completely closed by the "raft," is reported to have been enlarged by natural agencies. A raft of timber has, however, lodged therein, and threatens to choke up this channel also. The work of clearing out this cut will be undertaken in the near future. The recent freshet has brought into the river additional snags, which will require removal.

COMMERCE AND NAVIGATION.

The Oconee River is navigable from the mouth to the Central Railroad Bridge, a distance of 108 miles. This bridge being without a draw prevents boats from running above that point, and some portions of the river below it are so obstructed by snags and shoals that no regular runs are made through them. The boats engaged in the river traffic during the year 1890 were the *Tommie*, running from Little Oakey Bluff, 34 miles from the forks, to Ocmulgee Station, where the East Tennessee, Virginia and Georgia Railway crosses the Ocmulgee River 12 miles from the forks; and the steamer *Louisa*, running from Dublin (79 miles) to Red Bluff (41 miles), and also making irregular trips up the river from Dublin.

Digitized by Google

List and description of steamers plying on the Oconee River.

Name.	Registered tonnage.	Draft.		Number of trips during year.	Connecting with railroad at—
		Light.	Loaded.		
		Inches.	*Feet.*		
Louise	220	20	5	112	Dublin, Ga.
Tommie	175	16	4	68	Lumber City, Ga.

From July 1, 1890, to June 30, 1891, the above-named boats carried the following freights, acting as feeders to the railroads:

Article.		Shipped via—		Tons.	Value.
		Dublin: Dublin, Wrightsville and Tennille R. R.	Lumber City: East Tennessee, Virginia and Georgia R. R.		
Rosin	bbls.	44,560	12,544	12,848	$142,760
Spirits of turpentine	do	9,600	2,125	2,462	216,912
Cotton	bales	4,200	264	1,116	44,640
Guano	tons	1,650	.....	1,650	49,500
Merchandise	do	416	666	1,082	270,500
Total		.....	.....	19,158	724,312

In addition to the freights carried by the steamers, it is estimated that there were drifted down the river 25,000,000 feet or 60,500 tons of timber, valued at $225,000. These added together give the total value of the commerce of this river for the past year as 79,658 tons, valued at $949,312.

Freight rates have been reduced 50 per cent. since the work of improving the river began in 1878.

An estimate of the commerce that would probably be developed when the river is in a thoroughly navigable condition from Milledgeville to the mouth is given in Mr. A. S. Cooper's report on the survey of the Oconee River, printed as part of Appendix O 11, Report of the Chief of Engineers for 1890, to which I respectfully refer.

With the further improvement of the river, regular and more frequent trips can be made, and heavier loads carried during low-water stages. A large section of farming and timber lands would be opened up, and increased dependence would be placed on the river as a means of transportation for all classes of freight. In the counties bordering the Oconee River the population is about 90,000, the area of cultivated lands about 507,000 acres, and the value of all property from $10,000,000 to $11,000,000. The area tributary to the river is about 1,900 square miles.

In view of the information collected, it is estimated that the commerce on the river after improvement will amount to three times its present value.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1890, $5,748. Sapelo Light is the nearest light-house, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving Oconee River was adopted one appropriation of $25,000 has been made for the work and an unexpended balance of $201.18 transferred from a former appropriation.

Digitized by Google

The total expenditures under the present project to June 30, 1891, including all outstanding liabilities, were $8,120.31.

As outlined in my project of February 5, 1890, it is proposed to expend the available funds and any funds that may become available during the year in the removal of obstructions and in the improvement of the shoals in the river between Milledgeville and the mouth, should the railroad bridge near Oconee Station be so altered as to allow work to be done above that point.

The sum of $50,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every high-water season. They should, however, become fewer in number each year. From $1,000 to $5,000 will be required for the annual maintenance of the completed work. The work of removing obstructions has been in the local charge of Mr. F. C. Armstrong, assistant engineer, whose report is appended hereto.

Money statement.

July 1, 1890, balance unexpended	$201.18
Amount appropriated by act approved September 19, 1890	25,000.00
	25,201.18
June 30, 1891, amount expended during fiscal year	8,120.31
July 1, 1891, balance unexpended	17,080.87
July 1, 1891, amount covered by uncompleted contracts	8,010.00
July 1, 1891, balance available	9,070.87
Amount (estimated) required for completion of existing project	146,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for building steam snag boat, opened November 20, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price.	
		Using pine for upper works.	Using cypress for upper works.
1	Samuel W. Skinner, Wilmington, N. C.	$22,400	$22,474

Recommended that above bid be rejected, price being considered excessive. Amount available, about $18,000.

Abstract of proposals for building steam snag boat, opened December 20, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price.	
		Using pine for upper works.	Using cypress for upper works.
1	Samuel W. Skinner, Wilmington, N. C.	$20,325	$20,750

Recommended that the above bid be rejected, the prices being considered excessive. Amount available, about $18,000.

Digitized by Google

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah Ga., June 30, 1891.

CAPTAIN: I have the honor to submit the following report of snagging operations on Oconee River, Georgia, for the fiscal year ending June 30, 1891:

The snag boat *Ocmulgee* was repaired in October and November, 1890, by the addition of a galley and two staterooms to boiler deck, the removal of galley from main deck, remodeling of men's quarters, addition of iron sheathing to bow, recanvasing of boiler and hurricane decks, calking of gunwales, and painting of the entire boat.

The snag boat *Ocmulgee* left Savannah, Ga, November 18, 1890, with the steam hoister in tow. She arrived at Tillman Bar (5), Ocmulgee River, on November 24, and leaving the hoister there, proceeded to Center Cut (37), Oconee River, reaching that point November 27, and commenced snag work at once.

In 1888–'89, the river was cleared of snags from the forks (0) to Goodwin Cut (19). Work for the year 1888–'90 on this river consisted of the removal of overhanging trees from the forks (0) to Little Buzzard Bar (74), and of snags from Goodwin Cut (19) to Little Oakey Bluff (34), and from Flat Creek (62½) to Little Buzzard Bar (74). Only the most troublesome snags were removed from the latter reach.

During the fiscal year ending June 30, 1891, operations were confined to the reach from Red Bluff (41) to Dublin (79). From Red Bluff (41) to Bonny Clabber (52½) only the worst obstructions were removed, but above this the river is in excellent condition.

Detailed statement of work to date.

	Snags.			Stumps.		Overhanging trees.			Trees girdled.	Logs on bank cut.	Rock removed from shoals.	Rock quarried and deposited in dam.	Logs and brush jetties.	Sunken flat.
	First class.	Second class.	Third class.	Over 6 inches.	Under 6 inches.	Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.						
											C. yds.	*C. yds.*	*C. yds.*	
1878 to 1890 (Report Chief of Engineers, U. S. Army, for 1890)	800	2,394	652	164	194	1,500	6,676	9,473	539	267	490	.....	25	.....
Fiscal year ending June 30, 1891	205	487	192	32	.....	21	118	176	1	42	.....	600	.....	1
Total to June 30, 1891	1,005	2,881	844	196	194	1,521	6,794	9,649	540	309	490	600	25	1

For better comparison of the work of the several parties, the reports have been amended to show first class, second class and third class snags. All logs and trees under water are considered as snags. Those of the first class are over 2 feet in diameter at butt; second class, over 8 inches and under 2 feet; and third class, under 8 inches in diameter. Overhanging trees pulled back are also noted, as this requires more time than simply cutting. I have changed the record of work done to June 30, 1890, as given in my report 1889–'90, by substituting fair proportions of snags over 6 inches as first and second class snags, and of overhanging trees over 6 inches as trees pulled back, so that totals for the future will be nearer correct.

Snag boat Ocmulgee.

Month.	Total days worked.	Number of days removing obstructions.	Explosives used.	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Rock deposited in dam.	Sunken flat removed.
				First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.				
1890.			*Lbs.*									*C. yd.*	*C. yd.*	
November	12	3	5	10	8	5	.....	.....	.....	.....	.....	.....	.....	.....
December	24	23	17	65	85	60	13	1	19	72	.....	35	.....	1
1891.														
January	27	27	40	51	178	52	9	6	1	2	.....	3	.....	.....
February	19	13	10	9	25	7	.....	14	75	79	.....	3	50	.....
March	17	.....	4	1	.....	.....	.....	.....	.....	.....	.....	.....	250	.....
April	26	4	17	6	15	9	3	.....	.....	.....	.....	1	300	.....
May	26	23	17½	63	176	49	7	.....	23	23	1	.....	.....	.....
Total	151	93	110½	205	487	192	32	21	118	176	1	42	600	1

Digitized by Google

Summary of work by localities—Snag boat Ocmulgee.

Locality.	Distance above mouth.	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Rock quarried and deposited in dam.	Explosive used.	Sunken flat removed.
		First class.	Second class.	Third class.		Pulled back.	Cut.						
							Over 8 inches.	Under 8 inches.					
	Miles.										*C. yd.*	*Lbs.*	
Center Cut	37	4	4	.....	.....	.....	.....	.....	.....	.....	.....	5	.....
Red Bluff	41	10	11	10	.....	.....	.....	.....	.....	.....	.....	.....	.....
Silver Bluff	42	5	3	2	1	.....	.....	.....	.....	.....	.....	.....	.....
Jack Williams Snag	43	2	9	2	.....	12	12	16	.....	.....	.....	.....	.....
Louisa Bluff	44	5	9	5	.....	2	.....	.....	.....	3	.....	.....	.....
Odums Ferry	44½	.....	.....	.....	.....	.....	33	37	.....	.....	.....	.....	.....
Tar River (lower)	46	5	.....	.....	3	.....	30	26	.....	.....	.....	.....	.....
Tar River to Gays Bight	46 to 50½	4	4	3	2	.....	.....	.....	.....	.....	.....	4	.....
Gays Bight to Upper Tar River	50½ to 52½	2	2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bonny Clabber	52⅝	4	24	8	.....	.....	.....	.....	.....	.....	.....	.....	.....
Above Bonny Clabber	53½	14	40	7	.....	.....	11	5	.....	.....	.....	.....	.....
Berry Hill	55½	4	14	3	.....	.....	.....	.....	.....	.....	*600	21	.....
Travers Bight	56½ to 56⅝	19	46	9	2	.....	2	10	.....	.....	.....	.....	.....
Branch Landing	58½	6	14	4	2	.....	.....	.....	.....	.....	.....	5	.....
Below Coopers Bight	59⅛	5	4	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shady Field Cut	63½	3	2	3	1	.....	6	7	.....	.....	.....	.....	.....
Above Shady Field Cut	64½	7	2	1	1	.....	9	4	1	.....	.....	.....	.....
Greens Folly	65	3	3	5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Above Greens Folly	66	16	25	11	3	.....	4	.....	.....	.....	.....	.....	.....
Wells Spring	66⅛	7	12	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Poor Robin	67	7	34	19	1	.....	2	4	.....	1	.....	.....	.....
Wring Jaw Bight	68½	9	38	9	.....	.....	.....	.....	.....	.....	.....	.....	.....
Above Wring Jaw Bight	68⅞	11	30	8	.....	.....	.....	.....	.....	.....	.....	3	.....
Smith Lake	70	5	21	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Above Smith Lake	70½	4	13	5	.....	.....	.....	.....	.....	.....	.....	.....	.....
Clark Landing	71½	11	45	16	1	2	1	.....	.....	2	.....	.....	.....
Fish Trap Cut	72½	14	37	28	14	4	8	67	.....	36	(†)	60	1
Drowning Cow Bight	73½	14	28	25	1	.....	.....	.....	.....	.....	.....	.....	.....
Little Buzzard Bar	74	5	13	3	.....	1	.....	.....	.....	.....	.....	.....	.....
Total	.....	205	487	192	32	21	118	176	1	42	600	98	1

* Quarried. † Deposited in dam.

The winter of 1889–'90 was very favorable for snag work, and in hopes of similar good fortune for 1890–'91 the boat was kept in commission, but one rise succeeded another, and the boat was tied up twice on account of the water being too high for work.

Fish Trap Cut (72½) had become very troublesome on account of the increased volume of water passing through a center cut lately formed. The best solution of this problem would have been to open the center cut, but there was no plant to remove the underlying clay, and the natural erosion of the river would take 2 or 3 years to effect the desired result. It was necessary to either open or close this cut, as the old river was filling up and the cut would not permit the passage of boats and rafts.

As the river was at a stage when economic snag work could not be carried on, the crew of the snag boat *Ocmulgee* quarried 600 cubic yards of rock at Berry Hill (55½) and Diamond Landing (61½), hauled it to Fish Trap Cut (72½), 50 cubic yards at a load, and deposited it in a dam across the lower end of the cut. The dam is 70 feet wide, and its greatest depth, 8½ feet, resting on hard sand overlying rock. The rock was deposited at high water, and a certain proportion was scattered by the swift current. Since the completion of the dam, the shoal in the river has cut out and no further trouble is expected.

All sloughs leaving and then reëntering the river should be closed. Usually they are incipient cut-offs; but in all cases the volume of water taken affects the channel, in some cases to the extent of forming shoals between the two points.

Digitized by Google

All the following points should be improved:

Locality.	Distance above mouth.	Locality.	Distance above mouth.
	Miles.		*Miles.*
Devils Elbow	3¼	Mitchells Lake	24½
Steamboat Bight	7¼	Joyces Bluff	32½
Frying Pan River	18–21	Jones Old River	37–40
Devils Trash Pile	18½	Bonny Clabber	52½
——— ———	23		

Frying Pan River should be obstructed but not closed, as the main channel would erode and create too many snags if required to carry all the volume at once.

Center Cut (38) should be opened and Jones Old River closed below it.

When the Central Railroad provides a draw to its bridge at 10 8miles, it will be necessary to continue the work of removing trees and snags to Milledgeville. The raft at Sweeneys Cut (120½) will have to be removed or a cut-off made, but, until a further examination, can not say which is better.

The only rock shoal below Dublin that may require attention is at Fish Trap Cut (72½), and this can be done with crowbars at extreme low water. This shoal was complained of some 5 years since, but since then no further complaint about it has been received.

The Central Railroad bridge (108) should be provided with a draw. At Dublin there are two bridges in process of construction; one a county highway bridge, and the other that of the Dublin, Wrightsville and Tennille Railroad, both on approved plans.

The Savannah, Americus and Montgomery Railroad bridge (30) is an obstruction to navigation, and should be replaced with a proper structure.

The snag boat *Ocmulgee* was in charge of J. D. Robeson, master, until April, when Mate J. G. Walker assumed command. I recommend both men for efficiency and attention to duty.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 6.

IMPROVEMENT OF OCMULGEE RIVER, GEORGIA.

The Ocmulgee River is formed by the junction of the South and Yellow rivers, about 20 miles below Covington, and flows thence in a southeasterly direction about 250 miles, where it unites with the Oconee to form the Altamaha. A detailed description of this river is found in my report of the preliminary examination and survey, printed as House Ex. Doc., No. 215, Fifty-first Congress, first session. For a special history of past work, see page 1258, Annual Report of the Chief of Engineers for 1889.

ORIGINAL CONDITION.

For the greater part of the year the river is navigable for steamboats drawing from 3 to 4 feet, but during the low-water season there are various shoals with depths of not more than two feet. The chief obstructions to navigation consist of rock shoals, sand bars, overhanging trees, snags, and sunken logs.

PLAN OF IMPROVEMENT.

The plan of improvement, as outlined in my report of February 5, 1890, provides for the establishment of a navigable steamboat channel

Digitized by Google

3 feet deep at ordinary summer low water, from Macon to the river's mouth.

This is to be obtained by: (1) Removing rock shoals and sand bars; (2) closing incipient cut-offs and revetting caving banks; (3) removing snags and logs from the channel and overhanging trees from the banks of the stream.

The cost of the improvement is estimated at $210,000, provided funds are regularly and adequately supplied.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

Between 1817 and 1837 the State of Georgia expended about $60,000 in the improvement of the river, $10,000 of which were used above Macon. In August, 1877, operations were begun under the project approved by Congress in 1876, and the work has been carried on at intervals, as the funds were available, up to March 18, 1890, when operations were suspended on account of the lack of funds. In all there have been removed from the river 7,705 snags and stumps, 13,144 overhanging trees, 359 cubic yards of rock, and 1,869 cubic yards of earth; 112 logs were cut up on the banks; 801 trees were deadened; 2 jetties were built at Tillman Bar, 2 snag dams at Ashley Landing, and 1 at Indian Timber Landing. Up to July 1, 1890, the total expenditures for the work, including outstanding liabilities, amounted to $79,396.73.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

Operations during the year consisted in the removal of snags, logs, and overhanging trees by the snag-boat *Ocmulgee* on the lower river, and by the work of a bank party between Macon and Cotton Box Cut-off; and in the construction of contracting works and the repairing of old works at Tillman's Bar by the steam hoister. The snag boat came to this river from the Oconee River on the 1st of June and has worked between the Forks and Cedar Creek, removing 173 snags and logs, 13 stumps, and 520 overhanging trees; 8 trees were deadened and 14 logs cut up on bank. In November a house-flat was built at Macon for the use of a bank party, which began work December 13. High water caused the suspension of work on March 15, but it was resumed May 21, and was in progress at the close of the year. There were removed 8,848 overhanging trees; 41 trees were deadened and 20 logs were cut up on the banks, partially improving a total length of river of 44 miles. The steam hoister working at Tillman's Bar drove 130 piles, 899 linear feet of sheet piling, sunk 320 square yards of brush mattresses, and wattled with brush 240 linear feet of old pile dam. High water required the cessation of work here in February before the work was entirely completed. It will be resumed as soon as the conditions are favorable for its continuance.

CONDITION OF WORK JUNE 30, 1890.

The river is in fair condition, so far as snags and overhanging trees are concerned, from its mouth to Hawkinsville; still, much yet remains to be done over that section of the river.

Above Hawkinsville, highway and railroad bridges have prevented work, except by means of a bank party. These bridges are to be removed. The work already done has been of great benefit to navigation. Boats now run at a stage of water from 3 to 4 feet lower than before the improvements were begun.

Digitized by Google

A detailed statement of the condition of the river is given in my report of February 5, 1890, printed as Appendix O 12, Annual Report of the Chief of Engineers for 1890.

No material change has taken place since then, except at Tillman's Bar, where the works of contraction have resulted in a considerable improvement of the channel, a least channel depth of 4.2 feet at low water being now available where there was formerly but 2.6 feet. These works were not entirely completed, owing to a rise in the river, which began about the middle of February and continued until early in May. During March the river reached a height nearly equal to the greatest height previously recorded.

The stability of the work at Tillman's Bar was therefore severely taxed. An examination made June 11, last, showed that it had suffered some damage, but not enough to impair its usefulness. The chief damage consisted in the undermining of those dams the foundations of which were not protected by an apron course of brush mattresses. Had it been possible to complete these apron courses before the freshet, it is believed that the dams would have withstood its force without injury. The addition of these foot mattresses and some slight repairs will place the work in good condition.

COMMERCE AND NAVIGATION.

In the early navigation of this river, about the beginning of the present century, pole-boats were used. Afterwards small steamers were added to tow upstream the flats which brought cargoes downstream with the current; and finally, about 1830, larger freight steamers took the place of tow-boats and flats. Macon was originally the head of navigation, and through freights were carried from there to the coast. The building of the Central Railroad to Macon in 1845 diminished the traffic on the upper Ocmulgee, and finally the construction of a highway bridge at Hawkinsville made that point the actual head of navigation, and cut off the fertile and finely timbered region between Hawkinsville and Macon from its natural means of communication with the markets. Below Hawkinsville the river traffic continued, but boats were able to run only 6 or 8 months of the year, being stopped at low water by snags, bars, and ledges. Now, however, owing to the works of improvement begun in 1877, boats are rarely stopped at low water, running at a stage 3 feet lower than the former limiting stage, and freight rates have been reduced at least 40 per cent. But the low water navigation is still dangerous on account of snags and shoals, and reduced loads must be carried at this stage.

The following is a list of the steamers plying the Ocmulgee River during fiscal year of 1890–'91:

Name.	Registered tonnage.	Draft.		Number of trips during year.	Connecting with railroad at—
		Light.	Loaded.		
		Inches.	*Feet.*		
Harry G. Day	299	16	4	8	Lumber City.
Lumber City	330	16	4	96	Do.
New South	*200	20	4	102	Abbeville
Swan	360	18	3½	39	Doctortown.
J. C. Stewart	235	18	3½	.....	

*About.

No new lines of boats have been started during the year. The *Harry G. Day* has been added to the People's Line at Lumber City. The *J.*

Digitized by Google

C. Stewart has been purchased by a lumber firm at Bullard's above Hawkinsville, but as the boat has just begun work, the number of trips made during the year can not be given.

The following table shows the composition and value of freight carried by steamers during the past fiscal year:

Article.	Shipped via—			Tons.	Value.
	Lumber City E. T., V. & G. R. R.	Abbeville S. A. & M. R. R.	Doctor Town S. F. & W. R. R.		
Rosin.....barrels..	24,348	14,400	12,712	11,578	128,650
Spirits turpentine.....do....	4,399	2,400	1,159	1,671	147,223
Cotton.....bales..	1,314	510	210	509	81,360
Guano.....tons..	.....	750	113	863	25,890
Merchandise.....do....	3,250	1,900	2,253	7,403	740,300
Total.....	.....	.....	.....	22,024	1,123,423

In addition to this there were 30,000,000 feet or 56,280 tons of timber rafted over the river during the year, and its value is placed at $270,000. This, added to the business done by the steamers, gives the total tonnage of the river as 78,304 tons, and the value of the same at $1,393,423.

As will be seen, the commerce of this river consisted of round and hewn timber rafted down the river to the mills and seaports, and the naval stores, cotton, guano, camp supplies, merchandise, etc., carried by the steamboats.

The Savannah, Americus and Montgomery Railway during 1889 had four steamers running from Abbeville to the seacoast, discharging their freight at Brunswick. During that year, up to October, they carried over that route 21,365 tons of rosin, turpentine, cotton, hay, oats, corn, flour, railroad iron, salt, guano, and general merchandise. This was valued at $1,268,000. This line was discontinued in the month named, when the extension of the road to Savannah was completed.

A full and carefully prepared statement of the conditions and circumstances that will affect this commerce in the event of the river being placed in a thoroughly navigable condition from its mouth to the city of Macon is contained in Mr. J. L. Van Ornum's report on the survey of the Ocmulgee River, accompanying my report of February 5, 1890, and printed as part of Appendix O 12, Report of the Chief of Engineers for 1890, to which I respectfully refer. It is impossible to make an accurate estimate of the increased commerce that would follow such improvement. But remembering that new boats are to be added to the Lumber City and Hawkinsville lines; that citizens of Macon await the opening of the river to establish a line of steamers to the coast; that more frequent trips can be made and larger cargoes carried; and that a new region between Hawkinsville and Macon will become tributary to the river, it is not an extravagant estimate to say that the commerce of the river may be increased 100 per cent. of its present value.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1890, $5,748. Sapelo Light is the nearest light-house, and Forts Oglethorpe and Pulaski are the nearest forts.

Since the existing project for improving the Ocmulgee River was adopted one appropriation of $30,000 has been made for the work, and

Digitized by Google

an unexpended balance of $244.95 transferred from a former appropriation.

The total expenditure under the existing project to June 30, 1891, amounted to $13,099.69.

As outlined in my project of February 5, 1890, it is proposed to expend any funds now available or that may become available during the present fiscal year in the removal of obstructions, and in the improvement of the shoals in the river between Macon and the river's mouth.

The sum of $50,000 can be economically and advantageously expended during the coming year. No permanent improvement can be effected, as new obstructions, caused by logs and snags, form during every high-water season. They should, however, become fewer in number each year. From $1,000 to $5,000 will be required for the annual maintenance of the completed work. The work of removing obstructions has been under the local charge of Mr. F. C. Armstrong, assistant engineer, whose report is appended hereto.

Money statement.

July 1, 1890, balance unexpended		$244.95
Amount appropriated by act approved September 19, 1890		30,000.00
		30,244.95
June 30, 1891, amount expended during fiscal year		12,575.89
July 1, 1891, balance unexpended		17,669.06
July 1, 1891, outstanding liabilities	$523.80	
July 1, 1891, amount covered by uncompleted contracts	5,340.00	
		5,863.80
July 1, 1891, balance available		11,805.26
Amount (estimated) required for completion of existing project		180,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposal for building steam snag boat, opened November 20, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price.	
		Using pine for upper works.	Using cypress for upper works.
1	Samuel W. Skinner, Wilmington, N. C.	$22,400	$22,474

Recommended above bid be rejected, price being considered excessive. Amount available, about $18,000.

Abstract of proposal for building steam snag boat, opened December 20, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price.	
		Using pine for upper works.	Using cypress for upper works.
1	Samuel W. Skinner, Wilmington, N. C.	$20,325	$20,750

Recommended that the above bid be rejected, the prices being considered excessive. Amount available, about $18,000.

Digitized by Google

REPORT OF MR. F. C. ARMSTRONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., June 30, 1891.

CAPTAIN: I have the honor to submit the following report of snagging operations on Ocmulgee River, Georgia, for the fiscal year ending June 30, 1891.

Work on this river began August 25, 1877, and has been continued at intervals since then to March 18, 1890. The present condition of the river is better than ever before. Boats run the entire year, and no accidents have occurred.

The river has been improved from the Forks (0) to Hawkinsville (133), the bridges at that point making it practically the head of navigation.

Detailed statement of work done to date.

	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Explosive used.	Rock removed from shoals.	Dirt removed from shoals.	Jetties.
	First class.	Second class.	Third class.		Pulled back.	Cut.							
						Over 8 inches.	Under 8 inches.						
										Lbs.	*Cu. yds.*	*Cu. yds.*	
1877–1890 (Report Chief of Engineers, U. S. A., 1890)	949	5,224	1,405	127	1,461	6,410	5,273	801	112	341½	359	1,869	2
1890–'91	45	103	25	13	1,138	3,120	4,231	54	34	2½			
Total	994	5,327	1,430	140	2,599	9,530	9,504	855	146	37	359	1,869	2

For better comparison of the work of the several parties the reports have been amended to show first, second, and third class snags. Those of the first class are over 2 feet in diameter at the butt; of the second class, between 8 inches and 2 feet, and of the third, less than 8 inches in diameter. All trees and logs under water are considered as snags. The number of trees "pulled back" is also shown, as it requires more time to pull back trees than to simply cut them.

I have changed the record of work done previous to this year by substituting fair proportions of snags of the first, second, and third classes for snags given, and similarly for overhanging trees, so that totals for the future will be nearer correct.

Summary of work by months 1890–'91.—Snag boat Ocmulgee.

Month.	Total days worked.	Days removing obstructions.	Explosive used.	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.
				First class.	Second class.	Third class.		Pulled back.	Cut.			
									Over 8 inches.	Under 8 inches.		
1891.			*Lbs.*									
June	26	24	2½	45	103	25	13	35	231	254	8	14

Digitized by Google

Summary of work by localities, 1890–'91.—Snag boat Ocmulgee.

Locality.	Distance above forks (0).	Snags.			Stumps.	Overhanging trees.			Trees girdled.	Logs on bank cut.	Explosive used.
		First class.	Second class.	Third class.		Pulled back.	Cut. Over 8 inches.	Cut. Under 8 inches.			
	Miles.										*Lbs.*
Round Bluff	4¼	2	3	1	....	.....	5	2	.....	.....	....
McRae Landing and above	15	1	3	.....	1	.....	11	1	.....	.....	....
Winslow Cut and above	22	.....	4	.....	4	.....	16	12	.....	2	....
Rocky Hammock and above	32	.....	4	4	6	.....	6	16	.....	.....	....
Reuben's Cut and above	35	2	4	.....	....	.....	19	15	.....	.....	....
Blackshear Landing and above	47	1	3	.....	....	.....	10	20	.....	2	....
George's Cut	51½	2	6	2	....	.....	6	9	.....	1	....
Dick's Swift and above	57½	1	10	1	....	.....	14	18	.....	2	....
Fodderstack Cut	59¾	4	1	.....	....	8	10	15	2	2	....
Lumpkin's Old Field and above	61½	.....	.....	.....	....	12	10	21	.....	3	....
McKinnan's Landing and above	64½	1	4	4	....	1	4	3	1	.....	....
Tiger Leap and above	69½	1	2	.....	....	.....	17	22	.....	.....	....
Mossey Log	77	1	.....	.....	....	7	8	6	5	2	2½
Blair's Boat Yard and above	78	3	3	1	1	4	15	7	.....	.....	....
Huley's Point and above	85½	1	2	3	....	2	9	18	.....	.....	....
Switches Trail and above	96½	9	28	2	....	.....	34	54	.....	.....	....
Poor Robin Landing and above	98	3	4	.....	1	.....	5	1	.....	.....	....
Bishop's Landing and above	100	2	5	2	....	.....	16	14	.....	.....	....
Phelps' Bluff and below	106½	3	5	.....	....	1	6	.....	.....	.....	....
Green Log Lake and above	107½	3	1	.....	....	.....	6	.....	.....	.....	....
Wilcox Point and below	111	5	11	5	....	.....	4	.....	.....	.....	....
Total	.....	45	103	25	13	35	231	254	8	14	2½

A bank party has been at work from Macon (203) to Cotton Box Cut-off (158½) preparatory to removing snags, when the alteration of bridges ordered to be made will permit the passage of boats.

A flat was built at Macon, and a party under Mr. J. L. Van Ornum, assistant engineer, began work December 13, 1890, and continued until March 15, when continued high water necessitated the cessation of work. Work was resumed May 25, 1891, and is in progress at present.

Summary of work done by months, 1890–'91.—Bank party.

Month.	Overhanging trees. Pulled back.	Cut. Over 8. inches.	Cut. Under 8. inches.	Trees girdled.	Logs on bank cut.
1890.					
December	154	445	826	24	.....
1891.					
January	352	877	1,755	6	.....
February	128	391	595	5	.....
March	52	173	289	5	3
May	105	220	330	1	6
June	312	783	182	5	11
Total	1,103	2,889	3,977	46	20

The East Tennessee, Virginia and Georgia Railway Bridge at Hawkinsville is provided with a draw, but the highway bridge at the same place has not been raised as intended. The East Tennessee, Virginia and Georgia Railway Bridge below Macon (193) will be provided with a draw-span this summer, but I have not heard that the Covington and Macon Railroad (201½) have taken any steps in that direction. The bridge of the East Tennessee, Virginia and Georgia Railway at Lumber City has been provided with a suitable draw-span, but the piles, old pier, etc., have not been removed, as required, and they constitute obstructions to navigation.

Digitized by Google

The sloughs leaving and entering the river should be closed, as in many cases they are incipient cut-offs; and in all cases they affect the channel of the river by taking a portion of the discharge. I mention some that will require attention.

Locality.	Above forks.	Locality.	Above forks.
	Miles.		*Miles.*
Owl Head	19	Henley Points	85
Reuben Cut	35	Switches Trail	96
Fodderstack Cut	60	Above Miller Shoal	99
Mossey Log	77	Cow Face	102
Big John Suck	82		

Cut-offs will most probably have to be made at Tiger Leap (69¼) and above Hollingsworth Ferry (72¾.)

Tillman Bar (5½) has been improved.

Very respectfully, your obedient servant,

F. C. ARMSTRONG,
Assistant Engineer.

Capt. O. H. CARTER,
Corps of Engineers, U. S. A.

N 7.

IMPROVEMENT OF BRUNSWICK HARBOR, GEORGIA.

About 2 miles above the city of Brunswick, Turtle River is divided by Buzzard Island into two branches, the smaller one, flowing to the eastward of the island and upon which the city of Brunswick is situated, being known as East River, the other retaining the name of Turtle River. These streams unite again about 1½ miles below the city to form Brunswick River. The lower part of East River forms what is known as the harbor of Brunswick. Operations for the improvement of this harbor have been carried on in accordance with a project of improvement prepared by General Gillmore, the officer then in charge, and printed as Appendix M 12, Annual Report of the Chief of Engineers for 1886. This project is an enlargement and modification of a previous one submitted by the same officer and printed as Appendix J 7, Annual Report of the Chief of Engineers for 1880.

For a special report of past work see page 1047, Annual Report Chief of Engineers for 1888, and the Annual Reports of the same officer since that date.

ORIGINAL CONDITION.

Turtle and Brunswick rivers have low-water depths of from 4 to 6 fathoms. Over the shoal in the East River, in front of the city, there was, when the existing project of improvement was adopted, a low-water depth of only 1½ fathoms. The mean rise and fall of tide is about 6.8 feet.

PLAN OF IMPROVEMENT.

The following comprise the main features of the plan of improvement:

(1) A training wall, projecting from the most easterly point of Buzzard Island and located approximately parallel to, and 1,000 feet or less distant from, the opposite shore of East River.

(2) A low dam across Turtle River, extending obliquely upstream from the upper end of Buzzard Island to the opposite shore of Blythe Island.

Digitized by Google

(3) Short spur jetties in the lower part of East River.
(4) Dredging in the vicinity of Turtle River Dam and on the shoal in the lower part of East River.

The training wall and spurs were to be constructed of Palmetto cribs loaded with stone, or of successive courses of log and brush mattresses loaded with riprap stone. The works were intended to establish and maintain a 15-foot low-water channel across the shoal in East River. The cost of the original project was estimated at $73,187.50, and as modified at $190,000.

In 1836 an appropriation of $10,000 was made for the removal of the shoal in East River. Since the adoption of the existing project eight appropriations have been made by Congress for the work, aggregating $162,500.

The project of improvement needs revision.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

A training wall was constructed, springing from a point on the eastern side of Buzzard Island, and extending N. 77° 30′ E. 335 feet; thence S. 14° 30′ 650 feet; thence S. 12° E. 3,549 feet to its present end.

The return work (with the exception of a shore extension 35 feet in length, built of log mattresses) and 780 feet of the main training wall were constructed of palmetto cribs; the rest of the training walls, 3,419 feet in length, of double raft mattresses loaded with riprap stone. Forty-nine cribs were used, 14 of which are in the return work. Each crib is from 20 to 25 feet in length and from 9 to 13 feet in width. The cribs were filled with brush and dredge material capped with stone, and rose from the bottom to the level of mean low water.

The double raft mattresses are from 30 to 40 feet wide, from 3 to 4 feet thick, and are loaded with about 12 inches of stone. In raising to a higher level the work already done, ordinary log and brush mattresses from 15 to 30 feet in width and loaded with from 4 to 8 inches of stone were used.

The old palmetto crib work being too narrow to build upon, foundation courses of mattresses 30 feet wide were laid behind these cribs and close against them. Upon this foundation courses of mattresses 20 feet in width were laid until the work was raised to the level of the old cribs. The next course then overlapped the old crib work, and upon this new crest mattresses of from 15 to 20 feet in width were laid. Along the return face and at the angle point apron mattresses were laid on the channel side of the work to guard against scour. The return face was brought up to mean high water, and the training wall to 4 feet above mean low water at the angle, gradually sloping down to the level of low water at a point 780 feet beyond.

In 1889 work was resumed, the crest being brought up with brush fascines loaded with riprap stone to about 5.5 feet above mean low water for a distance of 1,050 feet measured from the return angle of the work. There were used in this work 6,033.24 cubic yards of fascines and 988.78 cubic yards of stone.

Dredged cuts from 80 to 100 feet in width and from 14 to 15 feet deep at mean low water were made at various times across the shoal. The material removed consisted of a mixture of sand, loam, and clay, and aggregated 200,394.94 cubic yards.

Up to July 1, 1890, the total expenditures for the work, including outstanding liabilities, amounted to $127,457.73.

Digitized by Google

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

The contract for dredging was awarded on May 5 to P. Sanford Ross, he being the lowest bidder; but no work has yet been done owing to lack of plant.

Jetty work, under a contract entered into with John F. Gaynor on March 2, 1891, was begun on May 15 and completed June 10, 1891, the funds being exhausted. The work done consisted in raising the existing training wall with alternate layers of brush fascines and stone. The crest was brought up to about 5.5 feet above mean low water to a point 2,290 feet from the return angle of the work, an advance of 1,220 feet under this contract. In the execution of this work there were used 7,976.48 cubic yards of brush fascines and 1,737.93 cubic yards of stone.

CONDITION OF WORK JUNE 30, 1891.

The training wall is in good condition and is covered with a growth of oyster shells. The channel has, during the year, deepened by natural scour, there being now a minimum channel depth of 15 feet at mean low water.

COMMERCE AND NAVIGATION.

Previous to the year 1871 the city of Brunswick was of slight commercial importance, the value of the exports for that year being less than $500,000. In 1875 the value of the total exports had increased to $639,000. From that year up to the present, and especially since 1880, the importance of the city of Brunswick has increased with remarkable rapidity, and this rapid growth has been healthy and steady, with the exception of the year 1889, when the business of the port showed an increase of 50 per cent. over that of the year immediately preceding.

In 1880 the population of Brunswick was 2,891; it is now estimated at 12,000, and is still growing at the same rate. Taxable property has increased in value from $1,300,000 in 1880 to $6,000,000 in 1890. The naval-stores business did not begin here until 1875, but now there is a yearly business of more than $1,000,000. During the same period the lumber business shows an enormous increase. The supply of yellow pine timber is within easy reach of this port and is practically inexhaustible. White oak, ash, cypress, hard woods, American mahogany, and live oak are accessible within short distances, and all other classes of hard woods are attainable in unlimited quantities from Alabama, Tennessee, and north Georgia. In 1880 there were shipped from this port 37,000,000 feet of lumber; in 1890 the shipments of lumber amounted to 191,141,000 feet, valued at $1,914,145. These figures show an increase of about 75 per cent. in the amount shipped and the values given show a decrease in the price per 1,000 feet. Lumber was at one time the chief export of Brunswick, but cotton now holds that place. The exports of this staple during the season of 1884–'85 amounted to but 4,000 bales. Since then the exports of this article have increased wonderfully, and 187,446 bales, valued at $8,605,942, were shipped during the season of 1889–'90.

Two railroads, the East Tennessee, Virginia and Georgia and the Brunswick and Western, terminate here, the former reaching, with its connections, the North and Northwest and the latter extending across Georgia into Alabama and beyond.

Digitized by Google

The following lines of steamers have been established:

Mallory Line, Brunswick to New York, one steamship per week.
Brunswick to Savannah, two steamers per week.
Brunswick to Fernandina, one steamer per day.
Brunswick to Darien, one steamer per day.
Brunswick to river points, seven steamers per week.

The passenger traffic to and from New York over the line now in operation would be greatly stimulated were the outer bar improved so that the steamship company could positively announce the departure of its steamers from Brunswick at the same hour every sailing day irrespective of tides. The inward-bound steamers are often compelled to wait outside the bar for high water, and this circumstance tends to retard the development of the inward passenger traffic. Even with this disadvantage to contend with the passenger traffic to and from New York, over the Mallory Line, showed an increase in 1890 of 20 per cent. over the previous year.

Besides the lines of steamers previously mentioned, a large fleet of foreign and coastwise steam and sailing vessels is engaged in the Brunswick trade, which consists principally of shipments of cotton, naval stores, and lumber.

Shipments, foreign and coastwise.

Articles.	1888.			1889.			1890.		
	Am'nt.	Value.	Tons.	Am'nt.	Value.	Tons.	Am'nt.	Value.	Tons.
Cotton.....bales..	82,471	$4,373,291	20,618	171,607	$8,117,126	42,902	187,446	$8,605,942	46,861
Rosin.....barrels..	195,000	380,000	24,375	190,000	380,000	23,750	182,953	365,906	21,619
Turpentine.....do....	57,133	677,033	13,134	45,000	787,500	10,345	43,984	791,712	10,150
Lumber.....M feet..	88,274	1,182,985	214,027	110,000	1,540,000	266,200	191,141	1,914,145	349,648
Cross-ties....number..	159,000	60,000	15,000	204,000	81,600	20,400	265,000	106,000	26,500
Miscellaneous...tons..	316	7,905	316	1,132	28,289	1,132	3,034	75,872	3,034
Total.....	.....	6,691,214	287,470	.....	10,934,515	364,729	.....	11,859,577	457,812
Estimated receipts by water, foreign and coastwise.....	.....	2,937,426	117,500	.....	3,783,000	151,300	.....	3,937,500	157,600
Total commerce....	.....	9,628,640	404,970	.....	14,717,515	516,029	.....	15,797,077	615,412

These figures show an increase of nearly 50 per cent. in the trade of 1889 over that of 1888, while the tonnage of 1890 shows an increase of about 20 per cent. over that of the preceding year.

Persons interested in the trade of Brunswick estimate that owing to past work of improvement in the harbor freight rates have been reduced from 18 to 20 per cent., and that if the improvements were completed according to the existing project the total volume of trade would be increased 200 per cent.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1890, $5,748. St. Simon's Light is the nearest light-house and Fort Cinch, Florida, the nearest fort.

Since the work of improvement has begun the following appropriations have been made:

By act of Congress approved—

March 3, 1879	$20,000
June 14, 1880	10,000
March 3, 1881	5,000
August 2, 1882	25,000
July 5, 1884	10,000
August 5, 1886	22,500
August 11, 1888	35,000
September 19, 1890	35,000
Total	162,500

Digitized by Google

The total expenditures to June 30, 1891, including all outstanding liabilities, amounted to $147,667.61.

It is proposed to expend any funds that may become available during the present fiscal year in raising the training wall, in dredging, and in making surveys, when, after the necessary data have been obtained, the project of improvement can properly be revised.

The sum of $27,500 can be economically and advantageously expended during the coming year.

Money statement.

July 1, 1890, balance unexpended	$42.27
Amount appropriated by act approved September 19, 1890	35,000.00
	35,042.27
June 30, 1891, amount expended during fiscal year	20,209.88
July 1, 1891, balance unexpended	14,832.39
July 1, 1891, amount covered by uncompleted contracts	12,000.00
July 1, 1891, balance available	2,832.39
Amount (estimated) required for completion of existing project	27,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	27,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing training walls at Brunswick Harbor and Jekyl Creek, Georgia, opened February 14, 1891, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price for—			Total amount.
		Fascines.	Mattress.	Stone	
		Cu. yd.	*Sq. yd.*	*Cu. yd.*	
1	Charles C. Ely, Savannah, Ga	$1.62	$1.02	$3.50	$22,770
2	John F. Gaynor, Fayetteville, N. Y.*	1.48	.96	3.33	21.270

* Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable materials and service.

REMARKS.—Amount available, about $19,000.

Abstract of proposals for dredging in Darien Harbor, Brunswick Harbor, and Jekyl Creek, Georgia, opened on April 20, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price and locality.			Amount.			Total.
		Brunswick Harbor.	Darien Harbor.	Jekyl Creek.	Brunswick Harbor, for (estimated) 45,000 cubic yards.	Darien Harbor, for (estimated) 100,000 cubic yards.	Jekyl Creek, for (estimated) 10,000 cubic yards.	
1	P. Sanford Ross, Jersey City, N.J.*	$0.24½	$0.23	$0.24	$11,025	$23,000	$2,400	$36,425
2	Savannah Dredging Company, Savannah, Ga	.27	.27	.23½	12,150	27,000	2,350	41,500

* Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable service.

Amount available for Jeykl Creek, about $2,500.

Digitized by Google

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Brunswick, Ga., from January 1, 1878, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1878	116	32,584	850	36	10,218	270	41	19,008	493	193	61,810	1,613
1879	148	44,397	1,000	33	8,235	232	40	17,589	468	221	70,221	1,700
1880	271	77,656	1,892	36	11,219	317	39	14,996	432	346	103,871	2,641
1881	279	100,451	2,239	13	4,174	98	63	30,279	751	355	134,904	3,088
1882	335	123,149	2,659	7	2,095	57	63	26,958	694	405	152,202	3,416
1883	299	110,302	2,368	11	4,814	107	87	40,765	979	397	155,881	3,454
1884	239	88,063	1,898	10	4,434	88	126	62,818	1,435	375	155,315	3,416
1885	242	93,280	1,928	10	3,216	97	94	43,284	1,037	346	139,780	3,052
1886	229	88,244	1,751	7	3,262	48	98	47,798	1,164	334	139,304	2,835
1887	194	86,731	1,625	8	3,251	116	102	54,537	1,232	304	144,519	2,973
1888	821	290,590	8,619	9	2,991	76	147	80,330	1,729	977	373,911	10,424
1889	220	92,831	1,764	20	10,035	176	191	113,757	2,403	431	216,623	4,343
1890	316	196,701	3,844	23	7,513	186	126	71,158	1,559	465	275,372	5,589

CLEARED.

1878	124	32,767	874	28	9,231	236	49	21,218	550	201	63,216	1,660
1879	157	42,345	1,116	21	7,172	172	47	21,730	555	225	71,247	1,843
1880	270	78,913	2,010	14	5,010	115	48	19,970	550	332	103,900	2,675
1881	252	82,155	1,732	17	7,218	156	87	42,659	1,014	356	132,032	1,902
1882	278	96,170	2,086	19	7,761	170	101	48,699	1,139	398	152,630	3,395
1883	257	91,036	1,962	28	11,268	240	124	55,717	1,369	411	158,021	3,571
1884	176	62,927	1,322	38	16,209	335	148	70,612	1,633	362	149,478	3,290
1885	196	71,345	1,481	21	8,696	190	135	62,437	1,456	352	142,478	3,127
1886	184	67,020	1,413	17	7,528	159	117	56,280	1,305	318	130,828	2,877
1887	130	51,305	958	5	5,858	143	131	72,894	1,526	276	130,057	2,627
1888	785	266,152	8,240	13	4,715	116	173	102,360	2,236	971	373,227	10,592
1889	169	65,809	1,273	11	4,266	103	221	130,919	2,830	401	200,994	4,206
1890	247	122,820	2,024	18	8,745	165	172	107,197	2,261	437	238,762	4,450

COMMERCE.

Year.	Value of exports.	Value of imports.	Total collection.
1878	$1,372,842	$400	$4,500.97
1879	1,394,401	3,197	5,644.33
1880	1,702,570	8,098	17,723.27
1881	2,230,000	4,377	29,305.30
1882	2,700,000	2,734	20,058.90
1883	3,437,000	3,093	24,911.61
1884	3,500,000	958	19,780.32
1885	3,063,960	4,008	3,939.27
1886	2,828,656	2,397	5,834.43
1887	4,121,660	*2,815,769	37,520.00
1888	7,552,025	*3,140,231	7,438.04
1889	7,894,281	6,557	8,933.66
1890	7,355,841	7,326	5,748.00

*Coastwise and foreign.

Digitized by Google

Comparative statement of receipts and shipments of naval stores.

Year.	Receipts (barrels).						Shipments (barrels).							
	Stock on hand.		Receipts for year.		Total.		Coastwise and interior towns.		Foreign.		Stock on hand.		Total.	
	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.	Rosin.	Spirits.
1880..	3,000	600	36,495	8,661	39,495	9,261	29,339	8,371	7,201	650	2,935	240	39,475	9,261
1881..	2,935	240	67,562	13,490	70,297	13,730	37,029	8,621	18,077	3,009	15,191	2,100	70,297	13,730
1882..	15,191	2,100	104,357	23,459	119,548	25,559	46,785	11,533	52,972	11,826	19,791	2,200	119,548	25,559
1883..	19,791	2,200	80,078	16,105	99,769	18,305	9,846	5,183	74,687	12,229	15,236	1,893	99,769	18,305
1884..	15,236	893	105,622	23,449	120,858	24,342	22,859	2,565	98,983	20,167	8,016	2,610	120,858	24,342
1885..	8,016	1,610	92,958	20,900	100,974	22,510	20,197	3,556	68,814	26,169	11,963	2,785	100,974	22,510
1886..	11,963	2,785	139,366	34,625	151,329	37,410	30,898	15,620	75,094	10,629	45,337	1,161	151,129	37,410
1887..	45,337	1,161	125,546	32,238	170,883	33,459	22,356	7,959	111,731	23,986	36,813	1,403	170,890	33,439
1888..	27,098	2,420	140,820	37,643	167,918	40,063	29,746	8,339	120,159	27,901	18,013	3,823	167,918	40,063
1889..	.....	.....	186,000	45,000	.....	.....	17,753	6,889	152,394	29,560	31,869	2,259	202,016	38,708
1890..	31,869	2,259	212,374	42,813	244,243	45,072	37,553	11,772	145,406	32,212	29,421	1,088	212,374	45,072

JOHN H. DEVEAUX,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

N 8.

IMPROVEMENT OF JEKYL CREEK, GEORGIA.

Jekyl Creek forms part of the inside passage between Savannah River, Georgia, and St. Johns River, Florida. It connects St. Simon Sound and Brunswick River at the north with Jekyl and St. Andrew Sounds at the south. The creek is about 5 miles in length, is separated from the Atlantic Ocean by Jekyl Island, and debouches into Brunswick River about 6 miles from the town of Brunswick, Ga.

Operations for the improvement of this creek have been carried on in accordance with a project of improvement prepared by General Gillmore, the officer then in charge, and printed as Appendix N 10, Annual Report of the Chief of Engineers for 1888.

ORIGINAL CONDITION.

With the exception of two points the creek has ample widths and depths to accommodate the largest class of vessels that take the inside route. About a mile from its northern end a shoal is found between the points where Lathram and Mud Rivers enter the creek, and from the mouth of the creek to the deep waters of Brunswick River, in the bight formed by the southern shore of the latter, there is an extensive mud flat. The least mean low-water depth across at the mouth of the creek was 3.7 feet. Across the shoal between Lathram and Mud Rivers it was 3 feet. The mean rise and fall of the tide is 7.1 feet.

PLAN OF IMPROVEMENT.

The following comprise the main features of the plan of improvement:

(1) A training wall at the mouth of the creek, designed to guide and

Digitized by Google

concentrate the ebb currents across the mud flats to the deep waters of Brunswick River.

(2) Closing Mud River by means of a dam at some suitable point, to prevent the escape of water through that branch at ebb tide.

(3) Dredging through the mud flats at the mouth of Jekyl Creek and in the creek proper, near the mouth of the river.

The training wall and closing dam were to be constructed of log and brush mattresses or brush fascines, and riprap stone below the level of low water; above that point stone alone was to be used. It was proposed to give the dredged channels a bottom width of 50 feet. The works were intended to establish and maintain a 7-foot low-water channel through the shoals. The cost of the project was estimated at $38,590. In the river and harbor act of August 11, 1888, the sum of $5,000 was appropriated for this improvement. This was the first appropriation ever made for the work. By the act of September 19, 1890, the sum of $7,500 was appropriated, making a total of $12,500.

SUMMARY OF OPERATIONS PRIOR TO JULY 1, 1890.

Dredging was begun on February 4, 1889, and terminated on account of the exhaustion of funds on March 19, 1889. During this period there were removed a total of 20,486.84 cubic yards, 12,546.33 cubic yards of which were removed from the bar outside of the mouth of the creek.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

The contract for dredging was awarded on May 5, 1891, to P. Sanford Ross, he being the lowest bidder, but no work has yet been done, owing to lack of plant.

The contract for mattress, brush, and stone work was awarded to John P. Gaynor on March 2, 1891, he being the lowest bidder. Operations were begun on May 13 and completed on June 8, and consisted in laying a foundation course of the training wall 40 feet in width and 513.5 feet in length. There were used in the work 2,282.22 square yards of mattresses, 336.18 cubic yards of stone, and 28.17 cubic yards of brush fascines.

CONDITION OF WORK JUNE 30, 1891.

An examination of the work made during the month of April shows that the dredged cuts have maintained their depths fairly well, except at one point on the outside bar, where a shoaling of 1 foot has taken place during the year. Five feet at mean low water can be carried through the channel over the outside bar, and 5.5 feet under the same conditions over the inner bar. Some trouble is experienced by large boats in making the turn near the mouth of the creek, the cut being rather narrow at that point.

COMMERCE AND NAVIGATION.

The commercial value of the traffic through Jekyl Creek during the year 1890 is estimated at about $962,000, and the amount of freight carried at about 28,500 tons. It is impossible to secure accurate figures because most of the freight is billed by the package and no record of the weights and values are kept. The above estimate is, however, believed to be a close approximation to the truth. The freights through this

Digitized by Google

channel, outward from the cities of Savannah, Brunswick, and Fernandina, consist mainly of general merchandise and mill supplies. The inward freights are cotton, naval stores, rice, fish, etc.

Tabular statement of commerce on Jekyl Creek.

Route.	Between—	Number of steamers.	Towing.	Trips.	Tons of freight.	Valued at.
Sea Island	Savannah and Fernandina	1	1 barge	Bi-weekly	26,500	$900,000
Cumberland	Brunswick and Fernandina	1	.....	Daily	600	17,000
Satilla River	Brunswick and Satilla River.	2	.....	Tri-weekly	1,404	45,000
Jekyl Island	Brunswick and Jekyl Island.	1	.....	Daily	.....	.....
Total	.....	5	.....	.....	28,504	962,000

Four tugboats through Jekyl Creek, towing 27 vessels, the total tonnage of which was 9,500 tons.

The steamers on the Cumberland route and the Jekyl Island route are passenger boats and carry but little freight. In addition to the boats above mentioned, many small craft carrying rice, farm and garden produce, fish and oysters, pass through this channel.

Owing to the shoal water in Jekyl Creek, the steamers passing through on their regular trips are often delayed several hours while waiting for a suitable stage of tide, and some are reported to have sustained injuries by running aground. The Cumberland route is a part of a through passenger line to Florida via the East Tennessee, Virginia and Georgia Railway, and the delays mentioned interrupt the schedule to the serious detriment of the passenger service.

The completion of the works of improvement will undoubtedly be followed by a large increase in the amount of commerce passing through Jekyl Creek.

MISCELLANEOUS.

The work is located in the collection district of Brunswick, Ga. Amount of duties collected in 1889, $5,748. St. Simon is the nearest light-house, and Fort Clinch, Fla., the nearest fort.

The following appropriations have been made for this work:

By act of Congress approved—	
August 11, 1888	$5,000
September 19, 1890	7,500

The total expenditure to June 30, 1890, including all outstanding liabilities, were $8,888.22.

It is proposed to expend the available funds and any funds that may become available during the year in carrying on the improvement according to the approved project. Should the appropriation become small and irregular the cost will be greatly increased. The sum of $33,950 can be economically and advantageously expended during the present fiscal year.

Money statement.

July 1, 1890, balance unexpended	$31.38
Amount appropriated by act approved September 19, 1890	7,500.00
	7,531.38
June 30, 1891, amount expended during fiscal year	3,919.60
July 1, 1891, balance unexpended	3,611.78
July 1, 1891, amount covered by uncompleted contracts	3,000.00
July 1, 1891, balance available	611.78

Digitized by Google

Amount (estimated) required for completion of existing project $26,090.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 26,090.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing training walls at Brunswick Harbor and Jekyl Creek, Georgia, opened February 14, 1891, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price for—			Total amount.
		Fascines.	Mattress.	Stone.	
		Cu. yd.	*Sq. yd*	*Cu. yd.*	
1	Charles C. Ely, Savannah, Ga.....	1.62	1.02	3.50	$22,770
2	John F. Gaynor, Fayetteville, N. Y.*.....	1.48	96	3.33	21,270

*Bid recommended for acceptance, he being the lowest responsible bidder, for the best and most suitable materials and service.

Amount available, about $19,000.

Abstract of proposals for dredging in Darien Harbor, Brunswick Harbor, and Jekyl Creek, Georgia, opened on April 20, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and address of bidder.	Price and locality.			Amounts.			Total.
		Brunswick Harbor.	Darien Harbor.	Jekyl Creek.	Brunswick Harbor for estimated 45,000 cubic yards.	Darien Harbor for estimated 100,000 cubic yards.	Jekyl Creek for estimated 10,000 cubic yards.	
1	P. Sanford Ross, Jersey City, N. J.*	$0.24½	$0.23	$0.24	$11,025	$23,000	$2,400	$36,425
2	Savannah Dredging Company, Savannah, Ga.....	.27	27	.23½	12,150	27,000	2,350	41,500

*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable service.

Amount available for Brunswick Harbor, about $12,000.

N 9.

IMPROVEMENT OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

The entrance to Cumberland Sound is situated between Cumberland Island, Georgia, and Amelia Island, Florida.

Operations for improving the channel across the bar at this entrance have hitherto been carried on in accordance with a project of improvement submitted to the Chief of Engineers by General Gillmore, the officer then in charge, dated June 30, 1879. A discussion of the general question of the application of jetties to this entrance is published as Appendix H 6, Annual Report of the Chief of Engineers for 1878.

For a detailed history of the past work, see page 1054, Annual Report of the Chief of Engineers for 1888.

Digitized by Google

ORIGINAL CONDITION.

The available depth of the entrance in its unimproved condition varied from 11 to 12.5 feet at mean low water. The mean rise and fall of tide is 5.9 feet.

The plan of improvement, as originally submitted by General Gillmore in 1879 and revised by the Board of Engineers in March, 1891, provides for the construction of two low jetties, composed of riprap stone, with a mattress hearting whenever admissible, resting upon a foundation mattress of brush or logs and brush, starting, respectively, from the shores on opposite sides of the entrance and extending seaward across the bar upon lines so directed that the ends will be parallel to each other and about 3,900 feet apart. These jetties are intended to establish a low-water channel across the bar not less than 19 feet in depth. The cost of the improvement was originally estimated at $2,071,023, and, as modified, at $1,606,500 for the completion of the low jetties and at $2,079,500 if high jetties are found necessary.

Nothing was ever expended in improving the entrance to Cumberland Sound previous to the adoption of the existing project. Since then appropriations have been made by Congress for the work, aggregating $592,500.

North jetty.—The shore end of this jetty is located on Cumberland Island, about 7,700 feet north 26° 30′ west from the eastern bastion of Fort Clinch. From this point it extends south 61° 30′ east 2,200 feet, thence south 80° east 5,172 feet to its present seaward end.

Work on this jetty was commenced in June, 1881, and suspended in March, 1883. In addition to the foundation-course, 7,372 feet in length, a second course extends from the angle point shoreward a distance of 1,439 feet. Foundation courses of two spurs, each 54 feet in length, are also laid on the harbor side of the jetty at distances of 1,627 and 1,800 feet, respectively, from its shore end.

The mattresses of the foundation course of the jetty vary in width from 25 to 52 feet and those of the second course from 20 to 25 feet. The spurs are 42 feet wide.

The mattresses are from 19 to 22 inches in thickness and are loaded with riprap stone to an average depth of 12 inches.

There have been used in the work 46,480 square yards of mattresses and 15,612 cubic yards of riprap stone.

South jetty.—The shore end of this jetty is located on Amelia Island, about 5,800 feet east 18° south from the eastern bastion of Fort Clinch. From this point it extends seaward a distance of 10,062.48 feet, measured along the axis of the work. From the initial point it runs as follows, viz:

	Feet.
Range 1, east	2,041.63
Range 2, north 68° 32′ east	5,625.37
Range 3, north 69° 32′ east	400.00
Range 4, north 71° 32′ east	400.00
Range 5, north 78° 32′ east	400.00
Range 6, north 78° 32′ east	400.00
Range 7, north 80° 2′ east	400.00
Range 8, north 81° east	395.48

In addition to the foundation course a second course 3,967.9 feet in length extends seaward along the second range, beginning at a point 917.7 feet from the intersection of the first and second ranges.

The mattresses of the foundation course vary in width on the first range from 40 to 50 feet and on the second range from 50 to 100 feet.

Digitized by Google

Digitized by Google

Digitized by Google

On all other ranges their width is 100 feet, as is also that of the mattresses of the second course. The mattresses average about 18 inches in thickness and are loaded with riprap stone to an average depth of 12 inches. This jetty has been brought up to the level of mean low water for a distance of nearly 3,123 feet from its shore end, and with a crest width of 16 feet shoreward of the angle and of 22 feet seaward of that point. The structure consists of riprap stone upon the mattress foundation. A hearting of oyster shells was tried, but being found to be disadvantageous and not economical was discontinued. The stone has stood well, the slopes assumed on both sides of the jetty being about 1 on 1¼. No breaking down of the work at any point has been observed. There have been used in the work 145,197.86 square yards of mattresses, 74,010.47 cubic yards of riprap stone, and 2,071.80 yards of oyster shells. Up to July 1, 1890, the total expenditures on both jetties, including outstanding liabilities, amounted to $479,550.28.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

The survey of Cumberland Sound having been completed, a project for the expenditure of the appropriation made by Congress, dated September 19, 1890, was submitted on October 8, 1890. This was referred to the Board of Engineers, whose report, dated March 11, 1891, is appended hereto.

The project of expenditure having been approved, a contract for the execution of the work was entered into with Mr. John F. Gaynor, the lowest bidder, on May 4, 1891. The first mattress was set on June 23, 1891. During the year the foundation course of the North jetty, composed of brush mattresses 100 feet in width, has been advanced 267.4 feet. There have been used in the work 2,769.35 square yards of brush mattresses and 382.38 cubic yards of stone. The work is being carried on in the breakers, where operations are always dangerous and often impossible.

CONDITION OF WORK JUNE 30, 1891.

An examination of the bar channel was made in April, and of the north and south jetties in June, 1891. The north jetty remains as noted in former reports. The condition of the south jetty is excellent; no breaking down of the side slopes is apparent, although the last work done has been exposed to severe storms for a period of nearly two years. There has been no appreciable movement of the bar seaward, but considerable shifting of the channel has taken place. The north shoal, which had moved toward the south jetty, contracting the channel to about 350 feet, was cut through during the year, leaving the bar channels with a shoal between them. The northerly channel was used for some time, but the southerly channel, close along the south jetty, continued to deepen, and now, although quite narrow, is nowhere less than 13 feet deep at mean low water, which is the same depth as reported last year.

COMMERCE AND NAVIGATION.

All of the commerce of St. Mary, Ga., and 90 per cent. of the commerce of Fernandina, Fla., are dependent on water transportation through Cumberland Sound.

The Florida Central and Peninsula Railroad, terminating at Fernandina, besides traversing a fertile and well-timbered country, pierces also the Florida phosphate fields, and much of the rock from the phos-

Digitized by Google

phate mines is brought by this road to Fernandina for shipment to coastwise and foreign ports. For the handling of this increased traffic, the railroad has built new wharves and extended its terminal facilities. From information derived from the owners of the principal mines it is estimated that the annual shipments of rock will aggregate about 300,000 tons.

The Mallory line has two steamships per week plying between Fernandina and New York, which carried during the year 1890 61,000 tons of freight. Fifteen steamers per week ply between Fernandina and local coastwise ports, and a large fleet of foreign and coastwise vessels engaged in the commerce of this port.

In 1890, the shipments, foreign and coastwise, amounted to 263,517 tons, valued at $2,724,168, and the receipts by water were 16,387 tons valued at $5,008,585.

Shipments and receipts, 1890.

Articles.	Quantity.	Tons.	Value.
SHIPMENTS.			
Foreign:			
Lumber ..... feet..	18,994,363	45,965	$284,915
Phosphate rock ..... tons..	9,678	9,678	193,560
Coastwise:			
Lumber ..... feet..	68,167,334	164,964	1,022,570
Phosphate ..... tons..	1,653	1,653	33,060
Shingles	245,350	200	911
Cotton ..... bales..	10,441	5,022	559,560
Rosin ..... barrels..	28,013	14,000	56,026
Turpentine ..... do...	2,178	1,089	36,026
Miscellaneous ..... tons..	20,946	20,946	537,600
Total	.....	263,517	2,724,228
RECEIPTS.			
Steel rails	.....	6,196	185,880
Coal	.....	341	1,705
Guano	.....	700	21,000
Miscellaneous	.....	9,600	4,800,000
Total	.....	16,837	5,008,585
Aggregate	.....	280,354	7,732,813

MISCELLANEOUS.

This work is located in two collection districts, the north jetty being in the district of St. Mary, Ga., and the south jetty in that of Fernandina, Fla. Fernandina, Fla., is the nearest port of entry. Amount of duties collected in 1888, $7,335.32. Amelia light is the nearest light-house and Fort Clinch, Fla., the nearest fort.

Since the existing project for improving Cumberland Sound was adopted, the following appropriations have been made for this work :

By act of Congress approved—	
June 14, 1880	$30,000
March 3, 1881	100,000
August 2, 1882	50,000
July 5, 1884	75,000
August 5, 1886	112,500
August 11, 1888	112,500
September 19, 1890	112,500
Total	592,500

The total expenditures to June 30, 1891, including all outstanding liabilities, were $488,347.

Digitized by Google

It is proposed to expend the available funds and any funds that may become available during the year in extending the foundation course of the north jetty, in accordance with the revised project of March 11, 1891.

The appropriations heretofore made have been entirely inadequate to an economical and advantageous prosecution of the work of improvement. The most satisfactory results can not be obtained with expenditures the next fiscal year of less than $1,000,000.

Money statement.

July 1, 1890, balance unexpended		$449.72
Amount appropriated by act approved September 19, 1890		112,500.00
		112,949.72
June 30, 1891, amount expended during fiscal year		4,775.94
July 1, 1891, balance unexpended		108,173.78
July 1, 1891, outstanding liabilities	$4,020.78	
July 1, 1891, amount covered by uncompleted contracts	90,979.22	
		95,000.00
July 1, 1891, balance available		13,173.78
Amount (estimated) required for completion of existing project		1,987,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for constructing jetty at entrance to Cumberland Sound, Georgia and Florida, opened on April 15, 1891, by Capt. O. M. Carter, Corps of Engineers.

No.	Name and residence of bidder.	Brush mattress (per sq. yd).	Log and brush mattress (per sq. yd).	Stone (per cu. yd).	Total.
1	S. W. Skinner and Thomas E. Wallace, Wilmington, N. C	$1.16	$1.20	$4.08	$127,360
2	John F. Gaynor, Fayetteville, N. Y*	.97	.99	3.49	107,830
3	P. Sanford Ross, Jersey City, N. J	1.22	1.22	3.95	128,150

*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable materials and service.

Amount available, about $97,500.

Digitized by Google

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Fernandina, Fla., from January 1, 1875, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1875..	212	117,363	4,192	47	10,379	359	12	7,437	135	271	135,179	4,686
1876..	210	141,354	4,749	25	4,893	179	28	9,232	249	263	155,479	5,177
1877..	150	100,581	3,343	31	3,768	217	40	12,547	404	221	121,896	3,964
1878..	183	120,845	3,900	17	3,985	101	22	8,294	215	222	133,124	4,216
1879..	205	133,020	4,133	28	10,634	252	10	5,639	126	243	149,293	4,516
1880..	270	146,722	4,470	34	22,396	598	22	9,463	240	326	188,581	5,308
1881..	273	171,548	4,186	17	11,899	314	24	11,503	271	278	195,040	4,771
1882..	239	146,383	3,279	16	9,056	242	15	6,639	151	270	162,078	3,672
1883..	183	96,937	2,453	6	1,769	43	14	5,229	137	203	103,935	2,633
1884..	176	105,061	2,864	3	865	21	10	4,029	88	189	109,755	2,973
1885..	169	111,698	3,131	7	999	47	22	9,785	210	198	122,482	3,388
1886..	205	147,418	4,014	7	2,112	53	15	5,187	146	227	154,717	4,213
1887..	349	317,798	5,030	19	6,402	122	22	8,565	220	390	332,965	5,372
1888..	274	179,130	4,456	19	7,152	156	18	6,789	177	311	193,071	4,789
1889..	262	164,229	3,908	48	16,434	369	39	12,936	363	349	193,594	4,640
1890..	267	172,202	3,948	40	14,683	305	33	11,518	306	340	198,403	4,559

CLEARED.

1875..	229	121,028	4,303	31	8,239	228	15	5,343	212	275	134,610	4,743
1876..	244	161,154	5,058	21	6,040	147	26	9,002	269	291	166,196	5,474
1877..	165	106,615	3,590	24	6,340	166	42	13,741	412	231	126,596	4,168
1878..	195	124,883	4,086	19	4,911	123	26	9,080	236	240	138,874	4,445
1879..	175	129,654	4,079	31	11,067	258	12	8,016	164	218	148,737	4,501
1880..	244	155,659	4,505	31	14,207	327	24	10,202	240	299	180,068	5,072
1881..	204	138,593	3,730	41	22,007	506	31	15,335	351	276	175,940	4,587
1882..	217	136,666	3,166	39	15,497	370	31	14,962	321	287	167,125	3,857
1883..	153	85,815	2,245	32	8,925	210	24	9,413	231	209	94,153	2,681
1884..	178	104,462	2,688	27	8,831	176	15	6,488	158	210	119,781	3,022
1885..	185	112,936	2,970	33	10,251	249	21	9,393	221	239	132,580	3,440
1886..	214	153,092	4,208	27	9,072	200	26	9,817	299	267	171,981	4,707
1887..	306	326,342	4,500	29	8,552	232	33	11,607	327	368	346,501	5,059
1888..	280	175,490	4,586	28	9,190	184	20	8,622	204	328	193,302	4,974
1889..	298	181,075	4,240	46	13,652	342	45	16,286	428	389	211,013	5,010
1890..	276	176,330	4,074	41	14,394	317	34	13,149	319	351	203,873	4,700

COMMERCE.

Year.	Value of exports.		Value of imports.		Total commerce.	Duties collected.
	Foreign.	Coastwise.	Foreign.	Coastwise.		
1875	$209,791	$1,119,979	$14,304	$755,718	$2,089,792	$1,817.84
1876	226,076	1,170,240	46,179	1,131,032	2,573,827	2,181.40
1877	310,225	676,855	19,304	1,146,363	2,152,747	2,376.00
1878	248,000	780,607	8,142	172,234	1,901,983	2,090.00
1879	275,470	921,368	11,038	1,360,432	2,568,308	3,424.00
1880	257,780	667,092	3,676	1,365,857	2,294,405	7,808.00
1881	242,100	1,064,394	11,791	1,786,546	3,104,831	8,183.00
1882	292,400	1,342,421	45,792	7,536,588	3,217;201	36,590.00
1883	248,600	2,573,010	11,229	2,262,755	5,095,594	5,566.00
1884	173,600	1,164,462	1,874	1,738,620	3,078,556	1,331.00
1885	214,726	2,134,541	4,180	1,502,544	3,855,991	1,451.28
1886	191,595	2,843,000	590	1,625,000	4,660,185	808.00
1887	226,960	3,500,000	23,896	2,000,000	5,750,856	3,400.00
1888	175,150	2,500,000	.....	650,000	3,325,150	4,655.66
1889	325,980	3,970,180	601	3,150,000	7,446,761	4,712.40
1890	478,475	2,245,753	10,902	4,997,683	7,732,813	7,335.32

JAMES A. PINE,
Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

Digitized by Google

Arrivals and clearances of vessels, and commerce, at St. Marys, Ga, from January 1, 1879, to December 31, 1890.

ARRIVED.

Year.	Coastwise.			Foreign ports.						Total.		
				American vessels.			Foreign vessels.					
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
1879	53	16,773	378	6	2,303	54	14	5,155	143	73	24,231	475
1880	30	8,982	202	2	694	17	16	6,409	185	48	16,085	404
1881	22	7,541	156	6	2,491	54	25	11,282	290	53	21,324	500
1882	28	10,504	196	1	371	7	15	5,723	146	44	16,598	347
1883	26	9,596	132	3	1,207	24	6	2,112	44	35	12,912	250
1884	32	11,294	224	1	539	9	6	2,334	57	39	14,065	290
1885	40	13,042	280	1	396	8	5	2,028	52	46	15,466	340
1886	20	7,882	140	1	321	7	6	2,086	56	27	10,288	203
1887	37	13,247	222	1	405	9	8	4,286	90	46	17,938	321
1888	55	20,897	440	1	433	8	3	1,365	32	39	22,695	489
1889	60	24,000	540	9	3,575	70	14	5,571	133	83	33,146	743
1890	39	16,328	300	6	2,058	45	7	2,856	68	52	21,242	413

CLEARED.

1879	53	16,773	378	10	3,577	83	14	5,155	143	77	25,505	604
1880	30	8,982	202	3	1,150	27	12	4,979	132	45	15,111	361
1881	22	7,541	156	7	3,362	68	29	12,463	323	58	23,336	547
1882	28	10,504	196	4	1,567	32	18	6,791	175	50	18,862	403
1883	26	9,596	182	3	1,207	24	6	2,112	46	35	12,915	252
1884	32	11,294	224	2	1,097	19	6	2,234	57	40	14,625	300
1885	40	13,042	280	3	1,195	25	4	1,595	42	47	15,732	347
1886	20	7,882	140	5	2,312	40	5	1,646	45	30	11,840	210
1887	.....	.....	.....	1	425	9	8	4,286	90	8	4,286	90
1888	56	21,330	448	5	2,086	41	5	1,587	46	66	25,273	535
1889	60	24,000	540	9	3,575	70	14	5,571	133	83	33,146	743
1890	.....	.....	.....	3	877	21	7	1,856	68	10	3,733	89

COMMERCE.

Year.	Value of exports.	Year.	Value of exports.
1879	$82,491	1885	$27,127
1880	70,411	1886	36,520
1881	149,333	1887	428,500
1882	47,216	1888	212,045
1883	26,902	1889	343,496
1884	22,517	1890	37,867

C. A. McWHORTER,
Deputy Collector.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.

PROJECT OF LIEUTENANT O. M. CARTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., October 8, 1890.

GENERAL: In accordance with your instructions of the 20th ultimo, I have the honor to submit the following project for the expenditure of $112,500 appropriated by act of Congress dated September 19, 1890, for "improving Cumberland Sound, Georgia and Florida: continuing improvement."

Digitized by Google

Operations for the improvement of the entrance to Cumberland Sound have, up to the present time, been carried on in general accordance with a project of improvement prepared by Gen. Q. A. Gillmore, late of the Corps of Engineers, U. S. A., and printed as Appendix H 6, Annual Report of the Chief of Engineers for 1876.

The cost of this improvement was estimated at $2,071,023.

With a view to a revision of the project, a survey of the entrance and its vicinity was executed under my direction in 1888, 1889, and 1890, by Mr. Milnor P. Paret, Assistant Engineer, whose report upon the work done in the first two years is appended hereto, while a summary of the results obtained in 1890 (current observations on Pelican Shoal) will be given herein:

The more important of the field work consisted in—

1. Triangulation.
2. Soundings.
3. Location of shore lines.
4. Tidal observations.
5. A line of levels connecting tide gauges.
6. Gauging with current meters in Amelia River, Cumberland Sound, and the entrance.
7. Offshore current observations.
8. Borings.

The triangulation, soundings, and location of shore lines cover the entire outlying bar and extend well into Amelia River and Cumberland Sound, and their results are given by Mr. Paret on a map drawn to a scale of $\frac{1}{1800}$. An index map on a scale of $\frac{1}{9600}$ is transmitted herewith.

The main part of the tidal work consisted in observations at the following points, the locations of which are shown on the map:

1. *Fort Clinch Wharf*, on the northern shore of Amelia Island, where about 2 months' day observations were taken, which have been used for the computation of the tidal data given below. At this point a self-registering tide gauge was established on April 15, 1890, which is still running, and the records of which will form a more reliable basis for the computation of mean tidal data than any that have been available so far.

2. *Beach Creek*, on the western shore of Cumberland Island, where about 3 months' day observations and 1 month's continuous observations were taken.

3. *Reed's Mill*, on the western shore of Amelia Island, where about 3 months' day observations and nearly 2 months' continuous observations were taken.

An attempt to establish a gauge near the shore end of the northern jetty failed.

The results of the above-named observations are embodied in the following table, heights being reduced to mean low water at Fort Clinch:

Table of tidal data in Fernandina Harbor.

Station.	Mean lunitidal interval of—		Mean duration of—		Reading of—		Mean rise and fall.
	H. W.	L. W.	Fall.	Rise.	H. W.	L. W	
	h. m.	*h. m.*	*h. m*	*h. m.*	*Inches.*	*Inches.*	*Inches.*
Fort Clinch	7 40	14 01	6 21	6 04	5.80	0.00	5.80
Beech Creek	7 52	14 09	6 27	6 08	6.13	0.07	6.06
Reed's Mill	7 51	14 04	6 13	6 12	6.10	—0.04	6.14

Digitized by Google

Besides the above tidal work the usual observations were made while current measurements were in progress, and from those data it appears that change of current from flood to ebb takes place about 35 minutes after high water on the Fort Clinch as well as on the Pelican Shoal Section, while change of current from ebb to flood takes place about 50 minutes after low water on the Fort Clinch and 25 minutes after low water on the Pelican Shoal Section; the duration of *ebb current* on the *Fort Clinch section* (that is, in the Amelia Basin) is therefore about 25 minutes *longer* than on the Pelican Shoal Section, while the duration of flood current is about 25 minutes *shorter* than on that section.

The *volumes* of Cumberland Sound and of Amelia River were gauged in 1889 during a period of excessive rainfall, and are therefore hardly indicative of the average conditions of flow. The more important part of the gauging work, viz, that on Pelican Shoal and Fort Clinch sections, was done in 1889 and 1890 under more favorable conditions and renders the following volumes as reduced to mean tidal conditions:

	Ebb volume.	Flood volume.
	Cubic feet.	*Cubic feet.*
Fort Clinch Section	4,367,496,484	3,690,262,183
Pelican Shoal Section	912,809,208	1,677,489,782
Total	5,280,305,692	5,367,751,965

A partial check on these results is furnished by computations given in General Gillmore's report of 1876. The tidal prism west of "Amelia Basin" (by this name the report in question designates that portion of the main channel which is situated immediately north of Amelia Shoal) is there given as 4,546,369,080 cubic feet, and by another method, based on the results of current observations made by the U. S. Coast and Geodetic Survey, the ebb outflow through the opening between Cumberland and Amelia islands is found to be 5,101,960,375 cubic feet. These figures agree so closely with the volume found above that we are justified in accepting the latter in preference to the much larger volumes found by the gaugings of Amelia River and Cumberland Sound, and rendered in Mr. Paret's appended report. Further investigation is called for, not only on account of the great difference between these two results, but also because the figures given above do not account for the fresh-water flow of the St. Marys River, but on the contrary shows a flood inflow slightly larger than the ebb outflow. If the area of the St. Marys Basin is assumed at 1,700 square miles, the average rainfall at 48 inches, and evaporation and absorption at 50 per cent., then this leads to a fresh water flow of 130,000,000 cubic feet during an entire tide (12 hours and 25 minutes), by which amount the ebb should be greater than the flood volume. As the discrepancy in the above volumes incident on this circumstance amounts to only about 4 per cent., it may be due to errors of observation. But it may also be due to the peculiar conditions of flow in Cumberland Sound, which is connected with the sea by another opening through St. Andrew Sound. It is generally assumed that the meeting of the tides takes place near the mouth of Crooked River, and while there is no reason to doubt the general correctness of this assumption, still it is probable that the point of slack water during flood tide (the place of meeting) is not precisely the same as during ebb tide (the divide). If that is the case, then the volume of ebb discharge through the Fernandina opening (apart from fresh-water flow) would not be the same as the volume of flood inflow, and

Digitized by Google

the above discrepancy might have its origin in this circumstance. It is also probable that the location of the point of slack water varies under the influence of the irregularities of tides, of winds, and of atmospheric precipitations, and more than that, that it does not remain stationary during one and the same tide, which circumstance may in a manner explain the great difference between the results of observations in Cumberland Sound and Amelia River and those on the Fort Clinch and Pelican Shoal section. In order to clear up these points, the above-mentioned further investigations should therefore include gauging of Cumberland Sound and Amelia River on the old lines, observations of fresh-water flow in St. Marys River, and current measurements in the vicinity of the mouth of Crooked River, with a view to determining the extent of the region inside of which the point of slack water moves on the ebb and on the flood tide and the way in which such movements take place under various conditions of tide, wind, and fresh-water flow.

An important feature of the results given above is the difference between ebb and flood volume on each section. It is found that on the ebb only about 17 per cent. of the entire volume escaped through the Pelican Shoal section, while about 31 per cent. enters on the flood. In General Gillmore's report of 1876 these volumes are given at 28 per cent. and 38 per cent., respectively. The difference between the present and the earlier figures may be looked upon as evidence corroborative of the correctness of both, in so far as we would expect to find the former smaller than the latter, firstly, on account of the present cross-section not extending as far down stream as the one of 1878, and, secondly, on account of the obstructing influence exercised by the northern jetty on the inflow and outflow over the shoals. The preponderance of ebb flow over flood flow through the Amelia Basin, which is reflected in the above-discussed figures, is of great importance for the maintenance of the channel, and a disturbance of these relations by any works of improvement should be carefully guarded against.

In order to deduce from the above volumes mean velocities, we have to consider the following quantities:

Mean cross-sectional areas of mean inflow and outflow.

	Ebb.	Flood.
	Square feet.	*Square feet.*
Fort Clinch section	94,222	97,676
Pelican Shoal section	54,610	62,562

Mean duration of currents.

	h. m.
On Fort Clinch section:	
Ebb current	6 35
Flood current	5 50
On Pelican Shoal section:	
Ebb current	6 9
Flood current	6 16

From these values, in connection with the volumes given above, we obtain the following mean velocities:

Mean velocities v of ebb and flood currents in Cumberland Sound entrance.

	Feet per second.	
	Ebb.	Flood.
Fort Clinch section	2.00	1.80
Pelican Shoal section	0.75	1.19

Digitized by Google

On the Fort Clinch section, the mean velocities, and consequently the volumes of flow, are remarkably evenly distributed, with the usual decrease in the immediate vicinity of the shores, while on the Pelican Shoal section the bulk of the ebb, as well the flood flow, is found near the Cumberland Island shore.

The greatest actual ebb velocities on the Fort Clinch section are found, as might be expected, well over toward the concave shore formed by the shoal, where at Bouy 6, at the time of maximum current, there is a surface velocity of 5.0 and a bottom velocity of 2.8 feet per second. The greatest bottom velocities during floods are found at the same point and amount to about 2.2 feet per second.

The off-shore current observations, made by Mr. Paret, appear to show that generally speaking the littoral currents run south-easterly during ebb and northwesterly during flood flow. Their strength during time of maximum current and under mean conditions of tide, taking the mean observed at the various depths, appears to be between one-half and three-quarters of a nautical mile per hour.

DEDUCTIONS.

Below the junction of Cumberland Sound and Amelia River the direction of the channel is approximately, as we should expect to find it, without the existence of Amelia River, with this exception, that a slight concavity appears on the Pelican Shoal side, which is reflected in the circumstances of the greatest maximum currents being found near this side. It seems that this portion of the mouth—the Amelia Basin—is in a state of permanence, due, probably, as suggested by General Gillmore, "to an equilibrium of hydraulic agencies rather than to any powers of resisting wear possessed by the channel on either side."

According to information antedating the commencement of improvements, this permanency may be said to extend to, say, about a mile eastward of Amelia, the channel continuing all the way on the above-mentioned concave curve of the Pelican Shoal side. It should be added that the eastern end of Amelia Basin has been steadily extending itself seaward, and that this movement continues to show the same tendency of southerly deflection, following a curve of about 4 miles radius, the center of which is located about 1½ miles southeast of Fernandina. The permanency of the channel continues until its gradually spreading currents are weakened to such an extent that their strength is insufficient to prevent the channel from being swayed to and fro by the varying action of wind and waves. The region where these deteriorating influences commence to predominate is easily recognizable on comparing maps of various dates, which show the channel paths over the outer bar in widely different locations. An interesting description of the probable course of events is given by General Gillmore in his report of 1876, in the following words:

Supposing a channel to exist forming an eastern outlet of the Amelia Basin in about a straight line with an assumed longitudinal axis of the basin, but unprotected by artificial works, the waves of translation, driven on by a northeast gale, having previously obtained great power and volume by rolling over an unlimited sea, will sweep along soft sand and broken shells and fill in the channel. The pent-up water of the flood tides in Cumberland Sound and Fernandina Harbor, will, under the influence of north and northeast winds, form an outlet in a more southerly direction. This motion of the channel will, of course, be retarded and complicated by the effects of southeasterly winds. In the course of years, the channel will have been forced so far south, slewing around so much in a southerly direction, that its track across the bar will be greatly lengthened by its obliquity; the edges of its banks will more rapidly and frequently be broken down by waves. The liability to

Digitized by Google

shoal and the constantly increasing obstructions will so impede the outflow that a moment will arrive when, aided by favorable circumstances, such as spring tides of uncommon height in connection, perhaps, with freshets and strong westerly winds, the ebb tide will break through the bar at some place more nearly in elongation of the deep-water axis of Amelia Basin, when, as in 1843, there will be two entrance channels.

It would seem to be evident that with the facilities now afforded to the water to make its debouch through a shorter and more conveniently located channel, the southern channel will pass a steadily diminishing volume of water, the deterioration of its banks will augment in a rapidly increasing ratio, and it will eventually fill up to a level with the surrounding bar and cease to be a ship channel.

The engineering problem then consists in the protection by proper means of that channel-route across the bar which appears to be least likely to be swayed by the agencies described above, and whose protecting works can be so located as not only to guard against them, but also to guide the flow in such a way that sufficiently strong ebb velocities are retained until deep water is reached. Considerations of the momentary existing channel locations should not enter into the selection of the route.

The channel-route least likely to be swayed, that is, the one offering in itself the most favorable hydraulic conditions, is evidently the natural prolongation of Amelia Basin, and if consideration be given to the tendency of the latter to extend its permanent channel eastward on a curve deflecting slightly southward, as described above, we are led to the continuation of the channel across the bar on such a curve. Should such a channel be protected on its northern side by a training wall forming a continuation of the concave shoal on the north side of Amelia Basin, there will also be gained such concentration of flow along the concave curve as may and probably will render a southerly training wall superfluous. The bulk of the flow will continue to hug the concave training wall, and will, it is believed, reach deep water with ebb currents sufficiently strong to keep the channel open. Finally it should be mentioned that the location of such curved northern training wall could not very well be better so far as protection against the prevailing northeasterly winds is concerned; that its construction will not affect the favorable preponderance of ebb over flood flow through Amelia Basin; and that at the point where it reaches deep water its axis is about parallel to the direction of the tidal currents.

The adoption of this plan would necessitate the removal of the central portion of the southern jetty, where two courses have been laid.

Although in my opinion the entire south jetty is improperly located, the shore end would advantageously remain, helping to prevent a slewing of the channel too far to the south. The foundation course of the present north jetty should be extended to a point near "the boilers" at Station E. It should then start from a point on the present south jetty, about one-quarter of a mile inside of the outer end of the same, and extend thence in an easterly direction across the bar on the before-described curve, reaching deep water about 3 miles east of Amelia rear beacon. Its exact location can perhaps best be submitted after additional field work recommended herein has been completed. When this seaward end has been brought up throughout its entire length (about 4,000 feet) to the height of mean low water, it is probable that a new channel across the shoals will be found to have been scoured out. When that channel has been sufficiently developed either by dredging or by natural scour the gap should be closed by building easterly across the present ship channel from the end of the north jetty near "the boilers."

Should it be found necessary the crest of the jetty may be gradually raised to the mean height of the beginning of ebb outflow. If this jetty should prove sufficient, as it probably will, for fixing the location of the

Digitized by Google

channel across the shoals and for protecting the same, then the length to be built will be less than what remains to be constructed if the present plan of improvement is adhered to.

The route selected by the latter penetrates the outer bar on the shortest line, but it can not be expected to yield any considerable results before the northern jetty has been constructed to arrest the still continuing southward advance of the shoals, and, furthermore, to confine and strengthen the ebb flow. If it be decided to adhere to the present plan of improvement, this portion of the work should receive prompt attention. The shore end of the jetty should, for the present, be left low, to allow unobstructed entrance to the flood tide; but to avoid scouring, the foundation course should at once be extended. This can be raised when necessary. By the construction of these works we may hope to obtain maximum ebb bottom currents of more than 2 feet over the bar, which are sufficient, under ordinary circumstances, to maintain the channel. But the plan of improvement remains open to the criticism that the completion of the jetties may affect the existing relations between ebb and flood flow through Amelia Basin in an unfavorable way, and that the offshore currents run across instead of parallel to the axis of the channel.

In view of all this, it appears that, notwithstanding the required removal of a portion of the work already constructed, it might be advisable to modify the project of improvement in the manner discussed above.

PLANS OF IMPROVEMENT.

The original project contemplates the establishment of a channel across the bar from 20 to 21 feet deep at mean low water, but as a low-water depth of 19 feet will be sufficient for all of the present and prospective needs of commerce, I recommend that further operations may be carried on with that object in view.

If the original general plan of the two jetties be adhered to, the following considerations are assumed to govern the character and general location of the work necessary to complete the improvement. The ebb currents issuing from Amelia Basin in the southeasterly direction imposed on them by the curved line of the northern shoals strike the south jetty obliquely and are deflected by it to the northeast. In order to utilize the full effect of the ebb on the bar, its whole volume should be thus deflected, and this necessitates the raising of the south jetty to the level of mean high water to a point about 5,600 feet from the shore measured along the axis of the jetty. From this point, the deflection of the current being accomplished, the crest of the jetty may be allowed to slope gradually to the mean level of the beginning of ebb outflow at a point about 1,000 feet farther on and to the foundation course at the present seaward end of the jetty. Thence, for the purpose of holding the channel until deep water is reached, a foundation course alone may prove sufficient. On this supposition the estimate of cost given herein is based, but it may eventually be found necessary to raise the outer portion of this jetty to the level of mean low water or even higher in order to more effectually confine and strengthen the ebb current across the bar. To assist in controlling and directing the ebb currents across the bar to deep water, as well as to prevent the inwash of the sands borne by the waves during the prevailing northeasterly winds, the northern jetty will probably have to be raised to the level of mean high water at its inner end and to the mean height of the beginning of ebb outflow throughout the rest of its length. If left at the height of mean low water, too much of the ebb would be lost over its crest.

Digitized by Google

Estimates for the cost of this jetty are given both for the height of mean low water and for that of the mean beginning of ebb outflow. Its location should be approximately along the crest of the shoals, limiting the existing channel on the north with its outer end about 2,800 feet from the extremity of the south jetty (the exact width of entrance to be determined later). Pelican Shoals sufficiently fulfill, at present, the purposes of a northern training wall, as is evidenced by the permanency of the channel throughout the Amelia Basin, but their permanency will be threatened by the greater flow during both ebb and flood, which will take place across them when the outlet across the bar is contracted by the construction of the north and south jetties. Already, due perhaps to a reduction of the outlet, caused by a recent encroachment of the northern shoals on the channel, there seems to be a tendency on the part of the currents to open a minor channel across the shoals to the north, the inner and outer 6-foot curves nearly touching at one point, while the shoals rise above low water on either side. This tendency, which will be greatly increased on completion of the jetties, must be checked and the shoals rendered permanent by extending the foundation course of the existing north jetty. If, in this minor channel across the north shoals, ebb volumes should be found to preponderate over flood volumes, then it should be entirely closed by raising the jetty across it to the level of the adjacent shoals or higher, as previously explained. Finally, the works of contraction may have to be aided by dredging to more quickly attain the requisite depth, and an estimate therefor is added to the cost of the other items. The total amount estimated as necessary for the completion of the original project is, in round numbers, $1,706,500, if the north jetty is brought up to mean low water only, and $2,079,500 if brought up to the mean height of the beginning of ebb outflow.

If the modified plan of improvement suggested be adopted the considerations which should govern the character and location of the work are as follows: The object in view is simply to reproduce as nearly as possible in the channel across the bar those hydraulic conditions which for many years have maintained the permanency of the channel through Amelia Basin. This is to be done by constructing a training wall on the northern side of the proposed channel, which shall serve the same purpose with respect to the new channel across the bar that the shoals north of Amelia Basin serve toward it, and to this end it should follow the curve outlined by the inner edge of those shoals and be raised to at least an equal height with them or to the level of mean low water. This training wall may be eventually raised to a greater height if found necessary. This requires neither the deflection of the ebb currents from the course which they seem naturally to seek, nor the contraction of the outlet for the tidal waters, with the consequent backing up of the water and possible disturbances of the present favorable relations between the ebb and flood volumes flowing through Amelia Basin and Cumberland Channel.

There will be no excessive overflowing resulting from leaving the crest at the level of mean low water, since no head is created by the contraction of the outlet and the offshore tidal currents are nearly parallel to the axis of the jetty at its outer end. Scour along the concave side of the jetty can be guarded against, if necessary, by short spurs.

The stability of the shoals north of Amelia Basin will not be threatened by increased tidal flow across them, as would be the case under the original project; but to guard against any tendency toward scour across them, the foundation course of the jetty should be at once extended across the shoals, and the cost of this is included in the esti-

Digitized by Google

mates given below. The additional cost necessary to raise the entire jetty to the mean height of the beginning of ebb outflow is also estimated, although it is not thought that it will be necessary to raise it to that height unless at its outer end.

The removal of a portion of the old south jetty, where two courses of mattresses have been laid, will be necessary, and also probably dredging to assist the currents in attaining the required depth of channel.

The total amount estimated as necessary for carrying out the improvement under this plan is, in round numbers, $1,108,000, or, if the jetty be raised to the height of the beginning of ebb outflow, $1,758,000.

I propose the following type of jetty to be used under either of the above discussed projects:

For all jetties a foundation course of log and brush mattresses, not less than 100 feet in width, and loaded with riprap stone. On this, two or more courses of mattresses loaded with stone, with widths determined by the depth of water, the number of courses to be laid depending on the height to which sanding over will extend. Thence to a depth of 5 feet at mean low water, riprap stone alone, the slopes being kept at about one on one from the foundation course to this height. Between the depth of five feet and the level of mean low water, especially if the crest is to remain at that height, the extra heavy riprap, with slopes of one on one and one-half should be used. The width at low-water level should be at least 16 feet if the crest is to remain at this level, and 22 feet if the jetty is to be raised to the mean height of the beginning of ebb outflow. Where the jetty is raised above low water I propose the use of blocks of concrete or natural stone (preferably the latter) weighing from 2 to 8 tons, forming the crest with a width of 6 feet, with heavy riprap on either side, having slopes above low water of about one on two.

Where the exposure is small a less expensive form of construction above low water might be adopted, as, for instance, a simple rubble mound.

ESTIMATES.

Estimates are based on the following prices for material in place in the work:

Ordinary riprap stone, per cubic yard	$3.25
Large riprap stone, per cubic yard	6.00
Blocks of stone, or of concrete weighing 8 or 9 tons, per cubic yard	12.00
Log or brush mattresses, per square yard	.80
Dredging, per cubic yard	.30

ORIGINAL PROJECT.

North jetty:		
247,777 square yards mattresses, at 80 cents	$198,221.60	
145,278 cubic yards ordinary riprap, at $3.25	472,153.50	
34,000 cubic yards large riprap, at $6	214,000.00	
18,000 cubic yards of concrete, or heavy blocks of stone, at $12	216,000.00	
		$1,100,375.10
South jetty:		
107,733 square yards mattresses, at 80 cents	86,186.40	
148,699 cubic yards ordinary riprap, at $3.25	483,271.75	
23,425 cubic yards large riprap, at $6	140,550.00	
		710,008.15
Dredging		80,000.00
Total		1,890,383.25
Enginering and contingencies, 10 per cent		189,038.32
Aggregate		2,079,421.57

Digitized by Google

PROPOSED PROJECT.

To height of mean low water:		
224,644 square yards mattresses, at 80 cents	$179,715.20	
74,881 cubic yards ordinary riprap, at $3.25	243,363.25	
31,533 cubic yards large riprap, at $6	189,198.00	
		$612,276.45
Dredging		270,000.00
Removing part of old south jetty		125,000.00
Total		1,007,276.45
Engineering and contingencies, 10 per cent		100,727.65
Aggregate		1,108,004.10
To mean height of beginning of ebb flow:		
302,643 square yards mattresses, at 80 cents	$242,114.40	
156,632 cubic yards ordinary riprap, at $3.25	508,054.00	
36,686 cubic yards large riprap, at $6	219,916.00	
19,422 cubic yards of concrete or heavy blocks, at $12	233,064.00	
		1,203,148.40
Dredging		270,000.00
Removing part of old south jetty		125,000.00
Total		1,598,148.40
Engineering and contingencies, 10 per cent		159,814.84
Aggregate		1,757,963.24

The estimates given herein, although only preliminary ones, to be revised as soon as the additional data needed have been obtained, are believed to be quite closely correct.

The first work to be done, under either plan proposed, should be the extension of the foundation course of the north jetty, and should, in the revision of the project, any changes be found desirable, they will not affect the location of that portion of the work which can be done with the amount of money now available. The mattresses should be 100 feet in width and loaded with 12 inches of riprap stone. I estimate mattresses at 80 cents per square yard and riprap stone at $3.25 per cubic yard, in the work.

To take advantage of the calm weather usually prevailing at this season of the year the work should be begun at the earliest possible date, and immediate consideration of the alternate projects submitted is requested.

SUMMARY OF PROJECT.

1. To reserve from $12,000 to $15,000 for engineering, contingencies, and for further surveys, as explained.
2. To expend the remainder of the appropriation in extending the foundation course of the north jetty, as explained.

APPENDICES.

1. Report of Mr. M. P. Paret.
2. Index map of Cumberland Sound, Georgia and Florida.

Respectfully submitted.

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Digitized by Google

REPORT OF MR. M. P. PARET, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., January 10, 1890.

SIR: I have the honor to submit the following report of the survey of Cumberland Sound, Georgia and Florida.

The work contemplated, as outlined in your letter of instructions of December 14, 1888, was as follows:

An hydrographical survey, embracing the territory lying between parallels 30° 40′ 20″ and 30° 44′ 00″, and from meridian 81° 29′ 00″ eastward to the 5-fathom curve at sea; or in more detail:

1. Triangulation of the harbor and determination of azimuth, with the reduction of the geodetic positions of triangulation stations.
2. Location of shore line and other topography.
3. Soundings, covering the area mentioned above.
4. Tidal observation at Beach Creek, in Amelia River, at Fort Clinch and at △ E, (or The Boilers); which will enable a determination of duration and range of tide, slope of water surface at various stages of tide, rate of propagation of tidal wave, etc.
5. The determination of direction and velocity of currents at different depths and for various ranges of tide, particularly the offshore currents.
6. The gauging of three channels, namely, Cumberland Sound between Cumberland and Tiger Islands, Amelia River near the mouth of Clark Creek, and the entrance between Cumberland and Amelia islands.
7. Borings on the bar and near the jetty to determine the character of bottom in connection with effect of scour or as a foundation for jetty construction.
8. Compilation of wind records.
9. A report on survey, giving methods pursued, results obtained, maps, diagrams, tables, etc.

TRIANGULATION.

The base line was measured by W. R. Curtis, assistant engineer, in 1888, and the triangulation taken by A. S. Cooper, assistant engineer, and George W. Brown, in 1887. The length of the base line from Station 5 to Station L, after supplying a correction for length of tape, was found to be 7,826.189 feet, and this length was used in the calculations and reductions of this survey. The closure of any triangle was less than 5 seconds.

The exact latitude and longitude of Amelia Light-House was known from United States Coast Survey records, and by triangulating in the light-house we were enabled to reduce directly the geodetic positions of the △ stations. For this purpose the light-house was observed eccentrically; the reduction to center will be found on page 3 of "Tables and Papers A," pages 1 and 2 of which give the numerical calculations in the reduction of the triangulation. In obtaining the azimuth, polaris was observed at western elongation on the nights of March 28, 29, and 30. The observations on the 28th and 29th were not satisfactory because of clouds interfering, consequently only those of the evening of the 30th were utilized in the final reductions.

SHORE LINES AND TOPOGRAPHY.

Transit lines were run around the shores and just back of high-water line; stakes were set every 350 feet. As a rule these lines were run north and south, or east and west; from every stake a back range stake was set at right angles to the transit line. For the purpose of turning these right angles readily a surveyor's cross was used. Points on this transit line were tied in with the triangulation stations at every opportunity, either by polar coördinates or triangulation. The back range points were always set as far away as possible, so that a clearly-defined range might be established. The main object in setting these ranges was that they might be used in running sounding lines; they at the same time afforded the best method of locating shore line, for ordinates were measured at each stake and at intermediate points when necessary, locating shore lines, buildings, ponds, jetties, etc. Outside of the shore line there was in reality very little topography proper to be taken. The buoys were located by transits from suitable triangulation stations; as in some instances the buoys were 5 or 6 miles away and rather difficult to distinguish between them, the steam-launch was sent from buoy to buoy, and at a given signal the transit man took an angle to it and also the time; on the launch the time of signal was taken by the recorder who wrote a description of the buoy at the same time. The high and low water lines, particularly about the northeast corner of Amelia Island, are decidedly variable, any northeast storm or even high spring tide will change them materially; high-water line was taken as best marked and defined by what appeared

Digitized by Google

to be a mean tide. Low water was taken from sounding lines whenever the surf would allow of the boat being brought near enough to the shore to get it; otherwise from the slope of the beach, which is generally quite uniform, as indicated by the last few soundings at termination of sounding lines.

SOUNDINGS.

The first soundings were taken on January 7, 1889, and the last on May 2, 1889.

In all there were taken about 35,000 soundings; the actual number of miles of sounding lines run was about 470.

An inspection of the large map shows that, as a rule, the territory is fairly well covered with soundings; there is one portion, however, the center and northeastern portion of the North Shoals, which might better have had a few east and west lines run over it.

TIDAL OBSERVATIONS.

Tide gauges were established at four places, namely, Beach Creek on Cumberland Island; in the entrance at Fort Clinch; at Reed's Mill Wharf in Amelia River, and at Station E, or the "boilers," at the eastern end of the North Shoals. The locality of each gauge is shown on the large map. The gauges were read every 15 minutes during the day, except for about three-quarters of an hour each side of slack water, when they were read every 5 minutes.

On days during which soundings were taken the gauge nearest the locality of the sounding work was read every 5 minutes during the day.

Observations began at Fort Clinch gauge on January 8, 1889. Between February 19 and March 4 no observations were taken, as heavy north and northeast storms prevailed to such an extent that the gauge was twice washed away. Finally a creosoted pile was driven, to which the gauge was made fast. The readings were continued from March 4 to May 9, excepting on days during which storms prevailed or gauge readers were eccentric. No continuous day and night readings were taken at this gauge owing chiefly to the necessarily exposed position of the gauge, but also largely to the fact that it was practically impossible to obtain reliable gauge readers; fully half a dozen day observers were tried, the result being that the last was perhaps more unreliable than the first. At Beach Creek the gauge readings began on January 7 and continued until May 1, 1889. Continuous day and night readings began on March 28 and continued until May 1, 1889. At Reed's Wharf, in Amelia River, the readings began on January 7 and continued until May 27, continuous day and night readings extending from March 23 until May 27, 1889.

The gauge at Station E (or the "boilers") was put in place on March 27, and observations were more or less continuous until May 24, 1889, when the gauge was removed. The location of Station E renders it extremely exposed to all storms, being near the southeastern end of the North shoals, or about 1½ miles east by north from the northeast corner of Amelia Island and about 3 miles east by south from the lower end of Cumberland Island.

Station E proper is on the north dome of the boilers of the steamer *City of Austin*, which was wrecked there in the year 1885. The dome stands about 2½ feet out of water at mean high water. Owing to the fact that the sea was rarely, if ever, quiet at this point, it was quite impracticable to use a staff gauge. A self-registering gauge was established in the following manner (please refer to diagrams 1 and 2 of "Diagrams and Tables B"):

The outside diameter of the dome was 5 feet and 11 inches and the inside diameter 3 feet and 5 inches; from the inside of the dome there projected up all round a sort of lip about 4 inches high. This lip was used to fasten our structure permanently to the dome. It was found that the water rose and fell inside the dome as the swells passed in over the shoal, but with a greater increase in the rise and fall. The water all entered and left the dome from below the line of low water. The problem was to build a structure which would at once act for three purposes as follows: To satisfactorily resist the extremely severe shocks to which it would be subject during northeast storms; to keep the clockwork and gearing perfectly dry in the roughest weather; and also by making the structure as nearly air-tight as possible, to form inside an air cushion and so prevent to a greater or less degree the surging up and down of the water inside the dome. A covering was made in the shape of a truncated cone, so formed that it would set closely over the lips referred to and stand about 2 feet in height above the top of the dome; the sides were made of 2-inch yellow pine, in strips of 3½ inches in width; these strips were tongued and grooved and the joints white-leaded. Hoop bands of ⅛-inch iron were driven round them, the top being further strengthened by an inner rim of two thicknesses of 1½-inch stuff. This inner rim also formed an additional support for the round cover which was used to close the structure, and at the same time gave a means of securely fastening down the

Digitized by Google

cover. The whole structure was secured to the dome by means of bolts one-half inch in diameter passing through the circular lip. Four ¾ inch bolts were used to fasten down the cover; the nuts of the bolts being removed the cover could be lifted up out of the way by means of a block and fall rigged to the cover and to an iron loop, which was secured fast to opposite sides of the structure and led up about 4 feet above the top. There was rubber packing between the lip of the cover and its supports. The joint between the top of the boiler and foot of the structure was tightly calked with oakum and given several coats of pitch. The space "O" between the lip and side of the structure was run full with a rich grout of Portland cement.

The self-registering gauge itself was one of those invented by Mr. A. Stierle.

The flooring was placed as high as possible to assist in keeping the clockwork dry. A box of ¾-inch stuff was built about the mechanism, so that when the cover was raised the sides and ends, which were hinged at the bottom, would fall down outwards, thus leaving the whole machine exposed and easily gotten at.

Sheets 1, 2, and 3 (Tables and Diagrams B) give the time and heights of all reliable high and low waters obtained at the boilers; there are forty-nine observations of high water, not consecutive, and forty-four observations of low water, not consecutive; the mean of these referred to the plane of mean low water as transferred by levels gives—

Mean high water = 6.703 feet.
Mean low water = + 0.535 feet.
Mean range = 6.168 feet.

Sheets 4, 5, 6, and 7 give comparative simultaneous gauge readings of high and low waters at the various gauges and the direction and force of wind. From such observations as we are enabled to compare we can infer that with calm weather or east winds the time of slack water at the boilers is from 5 to 50 minutes earlier than at Reed's Wharf; with light south winds the times are about identical; with westerly winds the times of slack water are from 5 to 15 minutes later at the boilers than at Reed's Wharf, and with northerly winds the times are from 0 to 20 minutes later at the boilers than at Reed's Wharf. A study of the comparative gauge readings would seem to indicate that there must be some cause other than a possible (and proable) difference in levels of half a foot, which would account for the diversity of irregularities in heights and times of respective stands of tides.

First as to the "times," any difference in them may primarily be attributed to the effect of direction and force of winds. Under conditions totally unaffected by extraneous conditions we would naturally look for the times of slack water to be about 5 or 6 minutes earlier at the boilers than at Fort Clinch. In illustration of what great irregularities are caused by winds and how unreliable it is to consider a short period of observations as giving any sort of mean result, let us make the following comparisons: From March 29 to April 1, the times of slack waters at the boilers are from 45 minutes to 1 hour earlier than at Reed's Wharf, light easterly winds prevailing. From April 9 to 12 some irregularity is observed, the times varying from 20 minutes earlier to 24 minutes later at theboilers than at Reed's Wharf, light southerly and westerly winds prevailing. From April 12 to 15 the times vary from 10 minutes earlier to 23 minutes later, light and stiff southerly winds. From April 15 to 18, with stiff north and northwest winds, the times are from 5 to 15 minutes later at the boilers. From the 18th to the 21st, with light easterly winds, the times are from 5 to 20 minutes earlier at the boilers. From April 21 to May 6, the times vary from 5 to 40 minutes later at the boilers than at Reed's Wharf, the winds being from light to stiff southerly, west and heavy northerly. From May 7 to 9, with northerly winds, the times are from 10 to 20 minutes earlier at the boilers.

There are few of these differences in times which might not be accounted for under the local conditions. With the heights of high and low waters it is quite a different matter. There are irregularities which it seems impossible to explain, even allowing that there is a difference in levels of half a foot in the transferring of the same from Amelia Island. From March 28 to April 15 the heights of high and low waters vary from between 0.39 foot to 1.10 feet for high waters, and between 0.33 foot and 0.7 foot for low waters. From the 15th to the 20th high waters are from 1 foot to 1½ feet higher, while low waters remain at an average of from five to six tenths of a foot higher. From April 20 to May 4 the differences are nearly constant at from five to six tenths higher for both high and low waters. From May 4 to 9 the high waters are not far from identical, while the low waters are from three to five tenths higher at the boilers. We might possibly look for as great a difference in heights, as from five to eight tenths, due to a combination of errors in levels of half a foot and storm influences, but there seems to be no practical explanation of the great differences of from 1 to 1½ feet on the 16th and 17th of April. By no possible disarrangement of the mechanism could the gauge be made to record higher *at high water* than the water actually stood. It might record higher at low water (for example, the float get fouled), but even then irregularities in the forms of the curves would appear, and they do not.

Digitized by Google

There seems to be but one possible explanation, other than the difference in levels, which would account for the high range of low waters at the boilers.

Diagram No. 3 (B) illustrates the explanation referred to. It was noticed that the universal direction of the swells at the boilers was from east to west. The diagram shows a profile of the bottom on the line traveled by the swells. Their general height is from 3 to 6 feet, considerably increased by easterly storms, and diminishing at high water. At or near low water the swells begin to break at A, or about 800 feet east of the boilers. This point of change from swell to breaker moves in as the tide rises, until, with a swell of but from 3 to 4 feet, they will not break before they reach a point a couple of hundred feet inside or to the westward of the boilers. With heavier swells they often break eastward of the boilers, even at high water. Now, the effect produced by the swell meeting the shoal is to retard and raise the lower portion of the wave and to accelerate and raise the crest of the wave. When this effect is great enough the swells become breakers. In deep water the areas of elevation and depression in the swell, above or below the plane of mean water surface, are equal; while, in shoal water, the areas of elevation are greater than those of depression, or the plane of mean water is raised.

It was no uncommon thing, even at midtide, to see the swells break at "A," and then form and break continuously from there in for a distance of several hundred feet westward of the boilers. A line is drawn on the diagram showing an elevated line of mean water level, due to the action of the swell on the shoals. Since the elevation of the float must be the same as that of the mean of the areas of elevation and depression, a glance at the diagram will serve to explain the idea of a lifting of the plane of mean water surface.

LEVEL LINES AND BENCH MARKS.

A bench-mark on the sea wall at Fort Clinch, which was set by Mr. Curtis in 1888, from benches of the U. S. Coast and Geodetic Survey, was used as an initial point. From this very careful lines of check levels were run, and bench-marks established at Station 5, Station C, Station B, Station D, at Reed's Mill, and two on Cumberland Island. A full description of these bench-marks, with their elevations above the plane of mean low water at Fort Clinch is given in the level book used on the survey. The lines were run only under the most favorable atmospheric conditions, the lengths of fore and back sights being equalized whenever possible. The levels were transferred from Amelia to Cumberland Island in the following manner: A bench-mark was made on the root of a tree at the south end of Cumberland Island; this bench-mark was so situated that with the level on either island, rods could at once be read on it and on the bench-mark on the sea wall at Fort Clinch. The level was placed about 100 feet to one side of the bench-mark on the sea wall, a rod read on it and then a rod read on the bench-mark on Cumberland. A large target having been arranged on the rod at Cumberland, the rod-man near the level signaled to the other with a flag, the Cumberland rod man having field glasses with which to observe the signals. The rod man at the distant bench-mark always shifted the target a foot or so up or down after each reading, so that the next sight might not in any way be influenced by the one preceding. In this manner 6 or 8 rods were read on each bench-mark.

The next observations would be taken in the same manner, only with the level at Cumberland instead of Fort Clinch. An equal number of observations having been taken from each place, the means of the apparent differences in elevation were taken; then half the sum of these means subtracted from the elevation of the bench-mark on the sea wall gave at once the correct elevation of the Cumberland bench-mark. This method obviates the necessity for any correction for curvature and refraction.

In transferring the levels from Amelia Island to the boilers the following method was used: The level was set up about 500 feet from Station 5 and on line between it and the boilers; a succession of rods were then read at Station 5 and the boilers in the same manner as outlined in transferring levels from Fort Clinch to Cumberland Island. The means of each of these sets were corrected for refraction and curvature; and the mean of the most reliable sets gave the elevation of the bench-mark at the boilers (see page 3 of paper B). The elevation of this bench-mark was thus found to be 12.47 feet above mean low water at Fort Clinch, and all records of the self-registering gauge were reduced from the elevation thus obtained. Still another method was used to obtain the elevation of bench-marks at the boilers and at Cumberland Island, as follows: Turning and instrument points, consisting of iron pipes driven to a firm bed, were established at points on the north shoals in such a manner that foresights and backsights would be practically equal, and the instrument as nearly on line between them as possible. Levels were carried from the bench-mark at Station 5 to a turning point near Station C, and then the level set up on the north shore of Amelia Island, so as to be exactly on line and half way between

Digitized by Google

the turning point near Station C, and another turning point on Pelican Shoal. The level was also set on the shoals half way between the boilers and Pelican Shoal turning point, and again half way between Pelican Shoal and Cumberland. In this manner rods were taken between the turning points, and the levels carried to each bench-mark. The results obtained by this leveling were not satisfactory, owing chiefly to our inability to get from point to point and do all the work on one tide, before the water rose sufficiently to have an influence on the level.

The results on all other leveling, except from Station 5 to the boilers, I consider excellent and reliable. Could sights have been obtained from the boilers to Station 5 and combined with those *from* Station 5, thus eliminating the effect of curvature and refraction, good results could have been obtained. This, however, was impracticable. It was also impossible, from the same position of level, to sight across an equal stretch of water to a point the elevation of which was known, and thus determine the actual amount of correction due to curvature and refraction. All indications are that the correction for refraction is not correct. What strengthens this belief is that the correction for curvature and refraction, as determined by taking the half sum of the means of the apparent differences in level between the bench-marks on the sea wall at Fort Clinch and on Cumberland Island, is 0.669 foot. The *calculated* corrections amount to 0.96 foot. If this discrepancy exists in sights between Fort Clinch and Cumberland, it would also no doubt appear in sights between Station 5 and the boilers. A reduced correction applied to the rods between the latter points would reduce the apparent discrepancy by such an amount. As before noted the reduction of mean low water at the boilers gave such a plane as being 0.535 foot higher than at Fort Clinch. This can hardly be considered as correct; or at least, if so, the condition causing such an effect must be entirely local; and under such an assumption all soundings east of the entrance have been reduced by the Fort Clinch gauge. That is, no change has been made in the plane of mean low water, but for nearly all the soundings east and northeast of Amelia Island, corrections have been made, *in time*, according to the locality of soundings and direction and force of wind, as outlined on page 7 of tables and diagrams B.

To obtain mean high and low waters, mean range and duration of tides, etc., the following observations have been tabulated: At Beach Creek, from March 29 to May 1, continuous day and night observations, comprising 61 high waters and 60 low waters; at Fort Clinch, from January 8 to May 9, day observations, and those somewhat interrupted by storms, comprising 83 high waters and 84 low waters; at Reed's Wharf, from March 29 to May 26, continuous day and night, comprising 114 high and 116 low waters. These observations have been tabulated and are given on pages 8 to 23 of tables and diagrams B. The first table gives the date, observed astronomical time and height of high and low waters (referred to plane of mean low water at Fort Clinch), the lunar date and hour of moon's transit, the lunitidal interval and corresponding hour (lunar). The second table gives the heights of high and low waters and lunitidal intervals, arranged according to the lunar hours in which they fall. The mean of those falling in each hour is then taken. These means were platted on cross-section paper (see diagrams 4 to 8, inclusive, B), and curves constructed through the points thus found. The lunitidal intervals for high water fall closely on the curves; those for low water are irregular, particularly at Fort Clinch. The heights of high and low waters plat rather eccentrically also, the low-water curves coming out better than the high water, the low water curve for Reed's Wharf being particularly good; the curve height or time is then picked off at each lunar hour and the means taken, the results obtained being as follows:

	High-water interval.	Low-water interval.	Ebb duration.	Flood duration.	High water.	Low water.	Range of tide.	Duration of stand.	
								High.	Low.
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*Feet.*	*Feet.*	*Feet.*	*m. s.*	*m. s.*
Fort Clinch	7 40 15	14 01 05	6 20 50	6 04 10	5.79	−0.004	5.794	21 0	18 0
Beach Creek	7 51 50	14 08 30	6 18 20	6 06 20	6.132	+0.075	6.057	15 50	11 50
Reeds Wharf	7 51 10	14 03 55	6 12 45	6 12 15	6.12	−0.04	6.16	13 17	12 0

Of course none of these determinations can be considered as being exact or perfectly reliable. This is naturally the result of but a limited number of observations, and those greatly interrupted and rendered abnormal by a season of perhaps unexceptionally stormy weather. However, some determinations are more reliable than others, and for good reasons. The observations at Reed's Wharf give decidedly the best results, since they continued over the longest space of time, the observers were the most conscientious, and the locality of the gauge was such as to give practically the conditions for the river at that point. I would consider the high and low water intervals and consequently the mean duration of flood and ebb tides as being correct

Digitized by Google

within a limit of 1 or 2 minutes, the low-water interval being the more reliable. The U. S. Coast and Geodetic Survey in "Tide Tables for the Atlantic Coast for 1889," gives the lunitidal intervals for Old Fernandina as follows:

High water, 7 hours 36 minutes.
Low water, 14 hours 7 minutes.

Replying to inquiries of mine, Prof. T. C. Mendenhall, Superintendent of the U. S. Coast and Geodetic Survey, says, in a letter, dated November 29, 1889, * * * "that the tidal differences for Old Fernandina, Fla., * * * are based upon a broken series of 39 high and 37 low waters observed at Old Fernandina between January 13 and April 8, 1871, and are deemed by us so unreliable that the tidal differences for Old Fernandina have been dropped from the tide tables for 1890, recently published."

Such being the case, it is unnecessary to make any further comparison than to note that it is evident our results at that point are more to be depended upon than those given in the tide tables. The determination of mean low water must be very near correct, and has every appearance of being the best reduction made; the mean high water and mean range must be correct within about a tenth of a foot. There is an apparent absurdity in the finding of the plane of mean low water as being 0.04 feet lower than at Fort Clinch; the presence of considerable fresh water from the St. Marys in the channel at Fort Clinch might account for this and also for the less reliable determination of the plane of mean low water at Fort Clinch.

At Beach Creek, both high and low water intervals may be 2 or 3 minutes out, the high water interval being probably the more nearly correct; the mean durations may be said to be correct within 3 or 4 minutes; these differences at Beach Creek must not alone be attributed to the small number of observations, but also to some extent to the location of the gauge; that is, if the gauge be supposed to give results which would also obtain in the sound opposite the mouth of Beach Creek. A decided eddy seems to make up around the southwest corner of Cumberland Island during flood tide and acts fully as far up as the mouth of the creek. This would have far more effect on the *times* than on the heights of slack water; again, easterly or westerly winds would drive out or hold back the water in the creek in a much more marked manner as to time than would the same winds affect the great body of water in the sound; still another point is that the considerable body of fresh water coming down the St. Marys must act appreciably in holding back the ebb tide in Beach Creek. The heights of mean high and low waters and the mean range can safely be considered as being correct within one-tenth of a foot. At Fort Clinch the mean high and low water intervals and the mean duration of ebb and flood must be correct within 4 or 5 minutes, the mean low-water interval being the best determination. The U. S. Coast and Geodetic Survey gives the lunitidal intervals at Fort Clinch as being 7 hours and 48 minutes for high water, and 14 hours and 2 minutes for low water. Our determination of the planes of mean high and low waters seems to give high water about one-half tenth too low and low water about one-half tenth too high, thus causing a range about one-tenth too small. The local conditions are such as to give apparently very anomalous results; the volume of ebb discharge from the sound and the St. Marys being quite three and one-half times as great as from Amelia River, it must tend to hold back the ebb flow from the Amelia Basin and not only diminish the velocities in Amelia River, but also shorten the time of ebb flow. If Cumberland Sound and its tributaries were but tidal basins, we might expect to find at Fort Clinch almost an ocean tide, that is, one having an equal duration of ebb and flood flow. There is, however, the fresh water flow from the St. Marys River, which is at all times considerable, and in time of freshets very great; this fresh water discharge acts directly on the ebb duration and will increase it quite perceptibly.

SLOPE OF WATER SURFACE BETWEEN GAUGES.

Such slopes are shown for different ranges of tide and at various stages on diagrams 9 to 12 (B) inclusive. The curves from the gauge at the boilers are platted with reference to two different planes; one, the plane of mean low water at Fort Clinch, as transferred by our levels to the boilers; the other, a plane 0.55 lower than the first. The slopes resulting are often anomalous in either case, but more evidently so with the higher plane of reference. The most typical tides are those of April 17, and 19; in the diagrams of these it is noticed that shortly after the times of high water and before the times of low water the curves all meet, crossing each other at or about the same height and time; in other words, at such times there is actually no slope in the water surface between the gauges. As a rule the slopes are the greatest (on the ebb) and about uniform from 1½ hours after high water to 1½ hours before low water. The slopes, of course, vary with the range of tide, winds, etc. The diagrams seem to prove almost conclusively that the high datum plane at the boilers is incorrect, for, using it, we notice that the water assumes an almost constant concave form;

Digitized by Google

that is, it is lower at Fort Clinch than at the boilers and inside gauges. Such conditions might occur occasionally for a very short period of time, but could not remain so throughout the tide, as the use of the high datum indicates.

Diagram 13 is interesting; on it is shown the predicted heights of high and low waters from March 29 to May 8, 1889, as taken from the tide tables for the Atlantic coast, and also such high and low waters as were observed by us at the different gauges and on corresponding dates. The observed Fort Clinch heights are shown on the diagram by means of small circles on the same verticals with the predicted heights. The theoretic heights illustrate very nicely spring and neap tides, the diurnal inequality, and the effect (about April 19) of the moon's greatest parallax.

Pages 24, 25, and 26, papers B, give times and heights of all high and low waters observed at the various gauges.

DIRECTION AND VELOCITY OF CURRENTS.

In addition to the general directions of the mean currents taken during meter observations at the regular buoys on the cross sections, various observations were made for direction with submerged floats, loaded rods, etc. The paths taken by such floats are shown on the large map, and also on the small scale map which gives the offshore current directions (see diagram 1 of tables and diagrams C). These directions are not meant to show mean condition directions, but only such as existed at the time and under the conditions of the observations. All of our observations go to show that there is quite a variation in surface, mean, and bottom directions (as well as velocities) for the varying conditions of tide, wind, fresh water flow, etc. At the time of running the rod floats for direction, just northeast of Amelia Island, the south jetty had not been extended sufficiently far for it to have any influence on the direction of the mean current. There is a tide ripple formed by the meeting of the two ebb tides, one from Cumberland Sound and the other from Amelia River. At the first of the ebb it lies slightly to the north of the bar buoy, and leads slightly northwest; as the tide becomes stronger and the volume from the sound greater, the ripples run closer to Amelia Island, south of the buoy and lead nearly southwest. In the channel northwest from Fort Clinch the current in changing from ebb to flood turns by way of the north around from northwest to nearly east; this would indicate that the flood comes in first over the shoals; this is the natural supposition when we reflect that the fresh water from the St. Marys River holds back the flood in the Fort Clinch Channel. In one instance it was noted running flood in the old Cumberland Channel for an hour and a half before it turned to flood in the Fort Clinch Channel.

From various notes made during observations on the Cumberland section and at other times, it was also found that the flood tide comes in around the lower end of Cumberland Island for some time *after* the ebb has started in the main channel opposite Fort Clinch. The greatest mean ebb velocity measured over the shoals was found in about the center of the old Cumberland Channel, and with a range of tide of 4.1 feet, amounted to 1.93 feet per second; the greatest mean flood was found at the same place, and, for a range of tide of 4.2 feet, amounted to 2.27 feet per second. Tables have been prepared, giving, for each buoy and tide observed on the various sections, the range of tide; greatest observed velocity; depth, and hours after slack water after which same was found; total depth at time of observation, and also greatest bottom velocity, and hour after slack water at which it was found. By "bottom" velocities must be understood velocities at 1 foot from the bottom; that is, on all inside work, but on the outside or offshore work the lowest velocities measured were at 2 feet from the bottom; consequently the so-called bottom velocities are slightly excessive. The tables referred to above are given on pages 1 to 5, inclusive, of papers and diagrams C. In nearly every case are the greatest velocities found in the deepest water of the section and when there is the greatest range of tide. There are exceptions to this, however, as for example, on the Amelia River section, on March 21 the greatest velocity is found at Buoy No. 3, in 40.5 feet of water; when observations were also taken on the same day at Buoy No. 2 in 46.9 feet of water. Again, the range of tide on April 18 was 1.55 feet higher than on March 21, and in deeper water we find on the 21st a velocity of 5.16 feet per second as against 4.1 feet per second on the 18th. In fact, there are several such irregularities in both flood and ebb velocities on the Amelia River section, and it seems most creditable to place it to the account of the very marked abrupt differences in depth in that vicinity. These irregularities in velocities are not noticeable on the sound section, and in but one instance on the Fort Clinch section. The greatest ebb velocity observed on the Amelia River section was 5.16 feet per second, the range of tide being 6.7 feet; and the greatest flood velocity was 3.81 feet per second, with a range of tide of 6.92 feet. On the Fort Clinch section the greatest observed ebb velocity was 5.07 feet per second, the range of tide being 6.32 feet; the greatest flood velocity was 4.08 feet per second, the range of tide being 6.9 feet. On the

Digitized by Google

sound section the greatest ebb velocity was 5.34 feet per second, with a range of 7.3 feet; the greatest flood velocity being 3.87 feet per second, with a range of tide of 6.9 feet. The greatest velocities fall quite uniformly between the second and fourth hours after slack water, and while, as a rule, they are from 3 to 4 feet below the surface, a noticeable exception is found on the Amelia River section, where the flood tides' greatest velocities are found, as a rule, considerably below the mid-depth.

Contrary winds would naturally tend to cause such an effect, but such winds did not occur on those days. The most probable explanation for such a condition of affairs seems to be that eddies are formed by the inequalities and irregularities of the bottom, and that such eddies are not constant in form, position or velocity obtained.

The bottom velocities which obtain are often quite considerable, running as high as 4 feet per second for ebb, and 3.39 feet per second for flood, on the Amelia River section; on the sound section for ebb tide we have a bottom velocity of 3.95 feet per second, and for flood, one of 2.8 feet per second; on the Fort Clinch section the greatest bottom velocity measured was for ebb tide, 3.69 feet per second, and for flood tide 2.82 feet per second.

Pages 6 to 11 inclusive of papers C give velocities at different times and depths and throughout the tide at various buoys on the three sections; from these tables are platted illustration velocity curves, which are shown in diagrams 2, 3, 4, and 5, "C."

OFFSHORE CURRENT OBSERVATION.

For this work observations were taken at five (5) buoys, which were placed as follows: No. 4, about 3½ miles east by south from Amelia Light, and in 5¾ fathoms of water; Buoy No. 5 was about 4½ miles northeast by east from Amelia Light and in 8¾ fathoms of water; Buoy No. 6 is 5½ miles northeast from Station 5 and in 8 fathoms of water; Buoy No. 7 is 3 miles northeast by north from Station 5 and in 6¾ fathoms of water, and buoy No. 13 being 2¾ miles north by east from Station 5 and in 4½ fathoms of water.

The pilot boat *Robt. H. Cowan*, Capt. James Bell, was used on the work and carried, in addition to the observer and captain, two deck hands; the boat was victualed and remained offshore until the observations were completed. The boat was held in place at the buoy by two or three anchors as occasion required. Observations were generally taken continually through the two tides, or for a period of about 14 hours. The pilot boat was allowed to trail in the direction of the current and the metre was hung over the bow in the following manner: A balance beam of 4 by 4 inch scantling was laid over the rail; from the outer end of this beam the metre was suspended. The lowering cable and anchor weight line passed through one pulley and the wires through a separate and smaller pulley. The so-called anchor line was fast to a heavy load weight, and when this weight was on the bottom the line was hauled taut and made fast. This line passed through a short piece of gas-pipe, on which the metre was so arranged as to allow of it readily turning in the direction of the current. The lowering cable was made fast to the upper end of the gas-pipe, and the anchor line forming a fixed vertical guide, the metre could be raised or lowered to any desired depth by simply having the lowering cable graduated. In its lowest position the metre was 2 feet from the bottom. By means of an adjustable counterpoise on the inner end of the balance beam, we were enabled to take up a vertical play, due to waves, of from 2 to 3 feet. In addition to the graduating of the lowering cable, the balance beam was marked for 1 fathom, in feet, and in a place convenient for use by the man who lowered and raised the metre. Observations were started with the metre in its lowest position, namely, 2 feet from the bottom, and raised by successive steps of a fathom at a time, the metre being allowed to record for from three to five minutes at each depth.

The battery used was generally of two cells (Leclanche) strength, except at buoy No. 15, where one cell sufficed.

The metre used was the Stackpole propeller No. 3, and its rating was obtained from Mr. E. A. Gieseler, assistant engineer, who had used it a few weeks previously on the Savannah River. The direction of the current was found by means of a submerged float, composed of a can 10 inches in diameter and 12 inches high, the can being suspended at any depth by means of a string made fast to a cork surface float, which was not of a sufficient size to materially affect the submerged float. These floats were run frequently during the tide and at various depths; they were allowed to run out for from 300 to 500 feet from the boat, the course to it being then taken with a ship's compass, and the float was then hauled in by means of a stout cord which was made fast to the surface float.

A chart of Cumberland Sound entrance has been made (see diagram 1, C), scale, 1 inch = 4,000 feet, on which are shown the positions of the offshore buoys, and all the current directions observed both outside and inside. At buoys Nos. 4, 5, 6, and 7 the general direction of the ebb current is southeast and of the flood northwest, the

Digitized by Google

ebb setting more to the eastward and the flood more to the westward as we go north; until when we reach buoy No. 13 the ebb sets from the northeast to northwest and the flood from west to south. At buoys Nos. 4, 5, and 7 the tide from the first of ebb to the last of flood turns with the hands of a clock from right to left, or from southeast to northwest by way of south; at buoy No. 6 the flood turns in the same way but the ebb turns from south to east. There were two tides observed at buoy No. 6 and the combination of the two indicates that the direction of the ebb flow is vacillating; this is no doubt due to the position of the buoy, it being where directions are more readily influenced by the great body of water coming out over the bar, which is less interfered with than that coming over the shoals.

At buoy No. 13 the tide from first of ebb to last of flood turns from east to west by way of the north. This is no doubt caused by the fact of the buoy being near enough to the shoals and Cumberland Island for the currents to be directly affected by the Cumberland Channel, which makes in about southwest from the buoy. The flood tide velocities observed at this buoy are about twice as strong as the ebb; this can not be accounted for only in the difference of range of tide, since it was but .7 feet greater on the flood than on the ebb. The local pilots agree in saying that they have always noticed that the flood tides run in through the old Cumberland Channel much stronger than the ebb runs out; that this was even more noticeable before the north jetty was built and when the channel was used in going to sea.

On diagram 1 "C" is also given a table of greatest velocities observed at the outside buoys, the range of tide, direction of wind, time after slack water, and so forth, also the greatest bottom velocity. The velocities are, of course, much smaller than those inside, but still large enough to show that they are decidedly not due to littoral currents alone. The ebb discharge from Cumberland Island entrance is practically inconsiderable, when taken in connection with the large ocean area which is no doubt influenced by it; nevertheless, it is probable that we would have to go a distance of from 15 to 20 miles to sea to get beyond the *practical* influence of the ebb flow from the sound, and it is more than likely that such discharges from the various inlets along the coast combine laterally before their influence seaward becomes inappreciable.

Mr. Henry Mitchell says: "Tidal currents (meaning littoral ocean currents) are rarely sensible far from land, since they are called into activity by the delays and the distortions of the tidal wave consequent upon the resistance of shoals, or confined and narrow channels. Very little is known of tidal currents on outside coasts except in the immediate neighborhoods of certain dangerous shoals. The coast currents in some places have a velocity of a third of a mile per hour in 30 fathoms of water. They are in some localities nearly parallel, in others nearly normal, to the general trend of the shore line, and, as far as the few observations we have seen may indicate, the directions of ebb and flood are not usually opposed, although lying at an oblique angle with each other."

The observed direction of our offshore flood currents, about north by west, agrees with what should be the theoretical direction. The tidal wave crossing the Atlantic Ocean tends to parallel the conformity of the coast; the more nearly it approaches the coast the more noticeable does this become. The contour of the coast from Hatteras to Cape Florida is of a decided concave form, the most westerly point of the concavity being at or near Cumberland Sound entrance. Now if the coast were straight from Hatteras to Cape Florida, we might without great error say that the wave would act normal to the coast for its whole length. However, as it is, the wave meets the concave outline, and from Hatteras south is deflected south, and from Cape Florida north is deflected northward. The natural consequence of this action is to bank up the water and cause a greater range of tide to exist at the center than at the extremes of the concavity. This is actually the condition of affairs, the relative ranges of tide being about as follows:

	Feet.		Feet.
Cape Hatteras	2.0	Brunswick (St. Simon entrance)	6.8
Cape Fear	4.4	Fernandina (Fort Clinch)	6.0
Charleston (Fort Moultrie)	5.6	St. Johns River (entrance)	4.6
Savannah (Fort Pulaski)	7.0	Cape Florida	1.4
St. Catherine Island	7.4		

This would indicate that the littoral currents coming south and north meet at about St. Catherine Island or a point about 60 miles north of Cumberland Sound entrance.

Still another disturbing element exists, but whether its influence is sufficiently great to affect the littoral currents or not, it is difficult to say; this is the influence of the Gulf Stream. The "axis" of the Gulf Stream is about 90 miles east of Amelia Island; what the width of the stream is at that point is not known exactly, but the "axis" of the stream was found by Lieutenant Pillsbury of the Coast and Geodetic Survey to be rather to the westward of the center of the stream.

Digitized by Google

In the Florida Straits, opposite Fowey Rocks light-house, Lieutenant Pillsbury found velocities of 3.4 feet per second for a width of about 30 miles, and coming up to within about 6 miles of Fowey Rocks Light and extending at the center to a depth of 150 fathoms. The general trend of the Gulf Stream from here northward to about opposite St. Andrew Sound is nearly north. It certainly seems consistent to reason that any such enormous volume of water as the Gulf Stream, and having such a considerable velocity, must, to some extent at least, exert an influence toward forming or controlling currents nearer in shore. No doubt at Fernandina its influence would be very small, but has it not transmitted effects along the coast?

Our observations may safely be said to demonstrate the fact that transverse currents exist for a distance of several miles offshore and that they attain velocities amply sufficient to carry off the sand or other sediment brought out by currents under jetty action; that is, when the jetty has been carried beyond the natural shoal limits.

Pages 12 to 17, inclusive, of papers "C," give velocities at different depths and times at the various offshore buoys. From these tables were constructed the curves shown on diagrams 6 to 13, inclusive, "C," which give velocities at constant depths throughout the tide, and velocities at a constant time at different depths. Pages 18 to 30, inclusive, of papers "C," give the time, depth, and velocity of all direction floats run at the offshore buoys.

GAUGING THE THREE SECTIONS.

The location of the sections were as follows: In Amelia River, with the eastern end at Reed's Wharf, the section crossed to Tiger Island, in direction about west-southwest. In Cumberland Sound, with the eastern end a few hundred feet northwest from the lower end of Cumberland Island, the section crossed to Tiger Island, in direction about southwest by west half west, to a point about 1,400 feet north from the mouth of Tiger Creek. The section across the channel in the entrance runs due north from a point on the north shore of Amelia Island about 1,600 feet east by north from station 5. The location of each section was chosen with a view of reducing to a minimum, the effect of eddies and contrary directions of ebb and flood currents. Since the directions of ebb and flood currents were not the same, and also owing to the fact that directions of mean currents varied during different stages of the same tide as well as for differing ranges of tide, it was of course impossible to so locate sections as to give uniformly normal directions. In view of the great length and depth of the sections, and the importance of the work, it was decided that the only practical method of obtaining discharges was with the use of electric current meters.

STACKPOLE PROPELLER METER.

See Diagram 5, D, for a sketch of the meter. The connections for make and break circuit were of agate and platinum, and the admission of salt water to the chamber had no direct effect on the regularity or reliability of the registration. The lowering cable consisted of fine seizing wire about one-eighth of an inch in diameter; the wire was made fast to a lead pipe, to which the meter was made fast. From the bottom of the lead pipe was hung a further lead weight of about 35 pounds. The bottom of this weight was 1.2 feet from the center of the meter, which was as close to the bottom as it was considered safe to carry the meter. The best localities for sections having been approximately decided upon after consulting maps, three parallel lines of sounding were taken at each location, each line being sounded over several times and always at slack water, to insure an accurate determination of the cross section. An attempt was made to gauge a section running from the northwest corner of Amelia Island to the southeast corner of Cumberland Island, but the location was found to abound in such a variety of confusing eddies, different for each range of tide, that the attempt was given up, and the section located farther toward the eastern end of Amelia Island, as previously explained. The soundings taken at the cross sections after being reduced to mean low water were platted on cross-section paper and most desirable positions for buoys determined upon. These positions being platted directly on our maps, and ranges erected on shore on lines of the sections; the buoys were dropped in position at slack water, being "cut off" by a transit from a convenient triangulation station. Five buoys, Nos. 2, 3, 4, 5, and 6, were placed on the Amelia River section, running across in the order named from Amelia to Tiger Island. The width of this section was 1,400 feet and greatest depth 55 feet.

See Diagram 6, D, for this cross section. It will be seen from inspection that the three sections, taken 100 feet apart, vary quite considerably as to depth. Such being the case, it was decided in the subsequent discharge reduction to determine the compartment widths by considering, for ebb tide, a mean between the section at the buoys and the section 100 feet above; and for flood tide, a mean between the

Digitized by Google

section at the buoys and the one 100 feet below; the buoys being dropped on the middle section. In arriving at this disposition it was reasoned that, as any abrupt change in the shape of the bottom must necessarily affect the direction and velocity of the currents, the most reasonable form of compartment width to be acted upon by currents similar to those found on the buoy vertical would be obtained by taking the mean of the sections more directly affected by the direction of the current.

On the sound section 7 buoys were placed, running from Cumberland and Tiger islands. They were numbered 1, 10, 11, 12, 13, 14, and 15. The width of this section was 4,500 feet and the greatest depth 36 feet. There was but little difference in the shape or area of the three sections sounded, so the middle one was used.

On the section below Fort Clinch 4 buoys were placed, running from the island northward. They were numbered 4, 5, 6, and 7. The length of the section was 3,140 feet and the greatest depth 49 feet. No marked difference appeared in three sections at this place, so the middle one was taken.

The Cumberland Sound section will be found on Diagram 7, D, and the Fort Clinch section on Diagram 8, D. The first observations were taken in Amelia River on March 16 and the last in the section below Fort Clinch on May 6. In all there were 16 flood tides observed and 20 ebb tides; the total number of measured and recorded velocities being about 10,100.

The method of taking the observations in the field was as follows:

The catamaran and crew would proceed to the buoy to be first observed, getting in position about half an hour before the tide turned. If an ebb tide were to be observed, they would run about 100 feet above the buoy and drop the forward anchor, then, dropping down about 100 feet below the buoy, would let go the stern anchor, then pull up on the forward anchor line until the buoy line lead vertically and the buoy taken aboard. In case a shifting of the current caused the position of the catamaran to change, in nearly every case could the buoy anchor line be brought to lead vertically by simply shifting the forward anchor line from one side to another of the bow.

Observations were then made with submerged and surface floats to obtain the direction and so be sure of getting the first of the change of tide. Actual slack water from surface to bottom was rarely found, the turn from ebb to flood or flood to ebb being almost instantaneous. In fact, it very often occurred that the tide ran ebb on top and flood on bottom, or *vice versa;* but such conditions rarely lasted more than a few moments, unless under the direct influence of strong winds. The directions of currents were obtained frequently during the observations, a submerged or loaded rod float being let go and its direction taken toward some known point on shore. As soon as the current showed signs of slacking observations began, the observer noting flood or ebb tides as his floats and observations indicated. The lowering cable having been marked in feet and fathoms from the meter up, and the electrical connections made, the meter was lowered to 1 foot below the surface. Then at the even minute the observer called time and read the register, noting in his book both this reading and the time. As the observer called time one of the men started to lower away the meter by unwinding the drum, the lowering being done at the rate of one-tenth of a foot a second and uniformly until the bottom was reached. Another man, watching a clock, called "tick" every 10 seconds and "time" on the even minutes. In this way the man lowering the meter could regulate his work quite successfully. After a little practice the men became quite expert in this manner of lowering the meter.

Previous experiments had proved that this lowering of the meter had no tendency to increase the number of revolutions; with some meters it had such a tendency, but with the Stackpole meters it had not. Lowering the meter at the rate of 1 foot per second gave no revolutions in slack water and did not increase the number of revolutions in running water. On the call of "time" at the end of each minute the observer read and noted the registration, and also noted the time and depth. The depth was always taken at each moment as a check, as occasionally the lowering man, through carelessness, would not have lowered the exact amount in each minute. In the same manner observations were taken and recorded at every minute, no pause being made from top to bottom. The depth having been previously tested, the observer and lowering man knew about when to expect bottom. The timekeeper, with his hand on the lowering cable, could readily detect the slight jar and slackening of the cable consequent upon the weight having reached bottom. The meter was then at once raised to the top and the observations repeated; when two such series of observations were taken the meter was made fast out of the water, oars unshipped, anchors taken in as rapidly as possible. The catamaran was then pulled to the adjacent buoy, the anchors dropped, and boat brought into position at once. Two series of observations were then taken at this buoy in the same manner as at the first, when the boat was again moved back to the first buoy and observations repeated there. In this way the tide was worked out between the two buoys.

Digitized by Google

For convenience, the bow anchor was generally left down, its line being made fast to the buoy, so that by simply picking up the buoy the catamaran could be hauled up at once to its proper position. The battery used was composed of Leclanche cells, and was from one to three cells strong, as occasion required. The time elapsing between observations at the same buoy, due to moving from buoy to buoy, averaged about 30 minutes, and depended upon the distance apart of the buoys, the strength of the current, and the time elapsing during the actual observations (this last, of course, depending on the depth of water). These observations were quite close enough, as was afterwards demonstrated, to construct between them quite reliable discharge and velocity curves. By this method of moving back and forth we were enabled to measure the discharge of two buoys on the same tide. If observations were taken on one day at buoys Nos. 2 and 3, then on the next day they would be taken between buoys Nos. 3 and 4, and so on, the whole number of buoys on the section being connected by the overlapping system. This system had the advantage of reducing by one the number of observations necessary to work out the section; but the principal reason for its adoption lay in the fact that it gave a means of obtaining by reduction the discharge at all the buoys for each tide when observations had been taken at but two.

The legitimacy of such a system and the method of reduction are discussed later in this report.

The method adopted of measuring the velocities, that of lowering the meter uniformly from top to bottom at the rate of one-tenth of a foot per second gave a very convenient way of computing the discharge. For example, if the meter had been lowered 37 feet in 370 seconds, and a total number of revolutions recorded of say 400, then dividing 400 by 10, and introducing the result into the equation of meter rating, we obtain at once a value of v (or a total velocity), which will equal the total *discharge* per second on such a vertical 1 foot wide for the mean time of observation. We have simply measured the sum of the velocities in feet per second in each foot of depth. The number of revolutions was divided by 10 to reduce it to the 1-foot unit, the lowering having been done at the rate of one-tenth of a foot per second.

METHOD OF REDUCTION OF OBSERVATIONS FOR DISCHARGE.

The following tables were prepared, the explanation of which follows:

	Sheets.
Cumberland section, ebb tide	22
Cumberland section, flood tide	17
Amelia River section, ebb tide	14
Amelia River section, flood tide	11
Fort Clinch section, ebb tide	6
Fort Clinch section, flood tide	6

See papers D, pages 4 to 38 inclusive.

Each table comprises eight columns of figures.

Column No. 1 is the mean time of the observation, that is, if the meter, being at 1 foot depth, was started at 10 hours and 12 minutes and reached the bottom at 10 hours and 18 minutes, the mean time of observation would have been 10 hours and 15 minutes.

Column No. 2 is the measured depth corresponding, that is, the depth is given by the lowering cable plus the distance from meter to bottom of weight (since the meter in its lowest position is at a certain distance from the actual bottom).

Column No. 3 gives the actual depth of the buoy at the time corresponding. For two reasons the measured depths were not considered the proper ones with which to make the reduction; a strong current giving high velocities would cause the meter to tail back somewhat, so that the measured depth would be greater than the actual depth, and again, owing to the unevenness of the bottom, varying depths would be obtained, since it was not possible to always bring the boat at anchor over exactly the same spot. The tailing back of the meter referred to of course had a tendency to bring the axis of the meter at an angle with the direction of the current; however, since the tailing of the meter was probably never great enough to affect the true measurement of the velocity, and more particularly since the rating of the meter was made under the same conditions, it is safe to say that the velocities and discharges were not materially affected. The depths were, however, and as much as 2 or 3 feet in 40, owing to the curved form assumed by the lowering cable. By actual depth is meant the cross-section depth, plus or minus the proper gauge correction.

Column No. 4 gives the observed number of revolutions of the meter in traveling from surface to bottom; since the number of observations actually recorded only refer to that portion of the depth between 1 foot from the top and $1\frac{9}{10}$ feet from the bottom, a certain number of revolutions were interpolated for each of these distances and added to the actual observed number. The sum is what is given in column No. 4.

Digitized by Google

Column No. 5 gives the corrected number of revolutions corresponding to the actual depth of column No. 3, and is a fourth proportional with columns Nos. 2, 3, and 4. It was argued that, since the actual depth would always be obtained by simply moving the boat a little to one side or the other and as the sum of the number of revolutions must be nearly directly proportional to the depth, the proper number of revolutions to use must be those as corrected for the actual variations in depth due to range of tide.

Column No. 6 gives the sum of the velocities in feet per second, obtained in each tenth of a foot of the actual depth; these values are obtained by introducing the values in column No. 5 as "x" into the equation $y=ax+b$ of the meter rating used, and by multiplying "b" by ten times column No. 3 and solving for "y."

Column No. 8 gives the observed acute angle which the direction of the mean current made with direction of the cross section at the time of observation.

Column No. 7 gives the total number of cubic feet per second discharged on the vertical at the mean time of observation, and is the vertical component of column No. 6 divided by ten.

The following reasoning was applied to this case: For the proper determination of the discharge the current must be supposed to act at right angles to the plane of the cross section; when it does not actually do so, some correction or reduction must be applied which will give results as nearly as possible as if such conditions had really existed. It is obviously impracticable if not unreliable to attempt any correction in the area or width of the cross section that would give an equivalent area or width at right angles to the section; considering one reason alone, since the direction of the current is continually changing it would necessitate a great amount of work not at all commensurate with the value or reliability of the results to be obtained.

If we consider the discharge on the vertical in one second as a *force*—and this seems perfectly justifiable—we can at once apply the resolution of forces, and, having such a force acting at a given angle, resolve it into components, vertical to and parallel with the direction of the cross section.

Our values in column No. 7 were obtained by simply laying a sheet of cross sectioned tracing paper over a large protractor and then, having the zero and center of the protractor under one of the horizontal or vertical lines, we lay off from the center of the protractor, at the proper angle, the given discharge, using any convenient scale; then the length of the perpendicular let fall on the line from which the angle is turned is at once the component sought. And as we have, until now, only considered the revolutions or velocities per tenths of feet, if we divide the vertical component by ten, we get the discharge referred to the unit used, namely, one foot.

Taking from these tables the mean times of column No. 1 and the corresponding discharge on the vertical in column No. 7 and platting them on cross-section paper by a system of rectangular coördinates, we obtain points which, if connected by a curve, form figures the areas of which give the total discharge on the vertical for the tide observed. Such curves are shown on diagrams 10 to 17 inclusive, D. The vertical scale is 1 inch=40 cubic feet per second, and the horizontal 1 inch=40 minutes; as the duration of the measured tide rarely varied much from the mean duration, each total discharge curve is given an approximate mean duration by simply shortening or lengthening the curves the required amount at the times of slack water. A still further correction for reduction to mean duration enters into the computations later. We have now arrived at that part of the reduction in which we utilize the results obtained by the method of "overlapping" observations.

Having determined the total discharge at each of two buoys for a certain tide, we thus obtain a ratio between such discharges; that is, the discharge at one buoy is a certain per cent. greater than at the other. The assumption on which the reductions are based is that, no matter how different the tidal conditions may be, such *percentage* of difference in discharge will practically remain constant. Let us consider the principal elements which, combined, give the discharge at any vertical for a certain tide. They are the varying velocities from slack water to slack water, the varying depths from slack water to slack water, the duration of tide from slack water to slack water.

The effect of winds may safely be said, as a rule, to influence the discharges at the two buoys proportionally in its combination with the other elements, which act as the vertical; any correction for it would be more or less of a constant, since it acts at each buoy with the same direction and intensity and has for its opposing forces the same relative forces. An exception to this, of course, might occur where there are eddies or when the body of water approaching one buoy is more sheltered from wind effect than that approaching the other. Our observations go to illustrate the probability that the effect of winds on the velocity and direction of currents is apt to be very much overestimated. From the fact that we generally found such effects inappreciable and that to attempt to apply a correction to discharges or velocities which would reduce them to *mean* conditions of wind would be quite an uncertain

Digitized by Google

and unreliable step, no correction for wind influence has been made in our reductions. With regard to the element of varying velocities, no known relation exists between such velocities and the range of tide.

Prof. Henry Mitchell, of the U. S. Coast and Geodetic Survey, gave much thought to and made many experiments with a view of demonstrating such a relation, but was unable to do so. Whatever agencies are at work tending to produce certain velocities, the same agencies are at work tending to produce the same velocities at the next adjacent buoy; the fact that identical velocities do not obtain must be attributed principally to the effects of shoals, the unevenness and varying roughness in sides and bottom of the stream gauged. It seems proper to assume that agencies causing certain velocities at two buoys will at least tend to produce the same relative velocities at such buoys under different tidal conditions. The element of varying depths is, strictly speaking, more or less of a constant, since the depth at each buoy must be increased or decreased by the same amount according to the height of tide; and the extra discharge obtained in (not *due* to) an increase in range of tide of so many feet should be applied additively to the discharge at each buoy rather than proportionally. This is practically the manner in which it has been applied, since the total discharge was obtained from the sum of the discharges actually measured, at the varying depths, and each discharge being the sum of the discharges per foot in depth.

As to the duration of tide, it is practically the same at all buoys, if it begins later at one buoy than another it will end earlier.

Consequently, since each of these three elements, velocity, depth, and duration, tends to uphold the theory that the percentage of discharge at adjacent buoys remains constant for varying ranges of tide, the natural combination of them will act to the same end in even a greater degree. In illustration of how closely the theory is borne out in practice, I submit the following table, showing the relative percentages between total discharges at buoys under different tidal conditions:

Date.	Range of tide.	Flood or ebb.	Discharge at buoy No. —	Per cent. of.	Discharge at buoy No. —.	Remarks.
	Feet.					
Mar. 29	6.8	Ebb	15	26.0	14	
May 2	5.2	....do	15	29.0	14	
April 1	6.82	....do	13	95.0	12	
8	3.6	....do	13	94.0	12	
2	6.22	....do	11	84.0	12	
5	4.45	....do	11	88.0	12	
6	4.45	....do	1	46.0	10	
15	7.0	....do	1	46.0	10	
Mar 28	6.8	Flood.....	15	59.0	14	
May 4	4.88	....do	15	61.0	14	
Apr. 6	4.15	....do	11	75.0	12	
20	6.15	....do	11	72.0	12	
Mar. 21	6.7	Ebb	3	92.0	2	
May 3	4.95	....do	2	99.9	3	Buoy No. 2 in eddy.
Mar. 25	5.35	....do	6	54.0	5	
Apr. 13	6.6	....do	6	47.0	5	
Mar. 25	5.35	Flood.....	6	89.0	5	
Apr. 13	6.92	....do	5	95.0	6	Heavy south wind, 10 to 18 miles per hour.

This table comprises all the double observations which were taken, and the small percentage of differences seems to indicate very strongly that the theory holds, indeed one might look for far greater differences than exist and still feel, considering the small number of comparisons made, that the theory had been reasonably well verified.

Pages 81 to 85, inclusive, D, give the observed and calculated discharge at each buoy for each tide observed on the three sections. The observed discharges are underlined and taken directly from the diagram of discharge curves. The deduced discharges are obtained in the following manner: Take for illustration the date March 29, ebb tide, Cumberland section; the discharge as measured at buoy No. 14 was 1,665,600 cubic feet. Now, by the observations of March 30, we find that the discharge at buoy 14 was 67 per cent. of the discharge at buoy No. 13. Applying this percentage to the measured discharge of March 29 at buoy No. 14, we obtain for the calculated discharge at buoy No. 13, for March 29, 2,465,088 cubic feet. Again, from observations on April 1 and April 8, we find that the discharge at buoy No. 13 is 94 per cent. of that at buoy No. 12. Applying this percentage to the calculated discharge of March 29, at buoy No. 13, we obtain 2,588,393 cubic feet as the calculated discharge at buoy No. 12 for March 29. In the same manner are calculated all the unobserved discharges on the various days at the different buoys. To obtain a discharge represent-

Digitized by Google

ing mean conditions I have simply taken the mean of the discharges on such days as those on which the tides were such that if the mean of the ranges on those days was taken a true mean range would be obtained.

Still another point has been considered in obtaining such means, and that is what I have called the mean mid-elevation of tide, for if true mean *conditions* are to be obtained, it is evident that in addition to mean range we must also consider mean mid-elevation (or its equivalent mean elevation of planes of high and low water), since it would hardly be safe to assume that the discharge would be the same with a constant range while the plane of high or low water varied 2 or 3 feet. The mean discharges for the various sections are shown on pages 81, 82, 83, 84, and 86. The mean tidal discharge (*i. e.*, corresponding to mean tidal conditions, excessive fresh water flow not yet eliminated), for ebb tide on Cumberland Sound section, is found by taking the mean of the discharges on April 15 and May 2. The mean of the tidal ranges on those days was 6.1 feet, and of the mid elevation 3.01 feet, closely agreeing with the proper mean range and mid-elevation. For flood discharges on Cumberland section, the mean of observations on the following days was taken. March 28, 29, April 5 and 20, the corresponding mean range of tide being 6.09 feet and mid elevation 3.12 feet. The mean tidal discharge of the Amelia River section for ebb tide is found by averaging the results of March 21 and 23, and April 3 and 13, the mean range of tide corresponding being 6.14 feet and the mean mid-elevation 2.921 feet. On the same section for flood tide, the mean was taken of observations on March 22, 23, and April 13, the corresponding mean range being 6.14 feet and mid-elevation 3.14 feet.

On the Fort Clinch section there were not sufficient observations to obtain from them a mean range of tide, so that it was necessary to reduce to mean discharge by another method. This was done by making the discharges directly proportional to the range of tide. The average of the thus reduced discharges was taken as the proper mean discharge on the vertical. It is extremely doubtful if this supposition that discharges are proportional to the range of tide be correct, indeed our observations go to show that such can not be the case. However, it is a step in the proper direction, and, so far as it goes, is no doubt all right, but there must be other factors which would enter into such a reduction, which would quite materially affect the results. If we have a tidal basin pure and simple, the area of which could be accurately determined at different levels, the range of tide by the mean area of course would give the actual discharge These conditions are by no means present in gauging ordinary tidal streams. When the disparity in ranges is not great and all close to the mean range, and when the total number of observations is great, then a reduction by proportioning ranges and discharges will give quite reliable results. In illustration of this I have prepared two tables of observed discharges at buoys, reduced to mean range of tide, using all the flood and ebb observations made on the Amelia River section; the results are shown on pages 87 and 88, papers D. From these tables it is observed that the tendency in each case is to bring the reduced discharge nearer to the final mean, although extremes of the reduced discharges vary as much as 25 per cent. from the final mean. In red ink, below the reduced means, I have placed the means as obtained by our regular and previously outlined method; a comparison is quite favorable. The greatest difference between ebb discharges as obtained by the two methods is but 6 per cent., and the greatest difference between flood discharges is but 4 per cent.

Having now found the mean tidal discharges on each vertical of the various sections, it remains to find the total discharge of the section. Pages 88 to 93, papers D, show this reduction.

The cross section proper, see diagrams 6, 7, and 8, D, are divided by compartments into widths, such that the discharge on any vertical will represent, as nearly as possible, the conditions for the full width of the compartment. As a rule, there is one compartment for each buoy or vertical, although in some instances intermediate or terminal compartments are introduced, when it is evident that such additional compartments will better represent the conditions. On the Amelia River sections there are 7 compartments for flood and 7 for ebb discharges, being of different width for ebb and flood for reasons already explained. There were but 5 buoys on this section, the two extra compartments being one at each end. Since the shore ends are somewhat irregular, the discharges at adjacent buoys are not representative for a width to mean mid-tide line, so the discharges at the end compartments were considered as being one-fourth of those adjacent.

On the Cumberland section there are seven buoys and eight compartments, the additional one being on the Tiger Island side, and is considered as having one-fourth the proportional discharge obtained from the vertical of buoy No. 15.

On the Fort Clinch section there are four buoys and seven compartments; the first on the Amelia Island side being given one-fourth the relative discharge of that on the vertical of buoy No. 4; compartment No. 3 has a relative discharge equal to the

Digitized by Google

mean between the discharges at buoys Nos. 4 and 5, and compartment No. 7 having a discharge equivalent to one-half that on the vertical at buoy No. 7.

By multiplying the discharge on each vertical by its corresponding width, and taking the sum of the results, we obtain the total discharges on the several sections.

Since the Fort Clinch section does not represent the total discharge between Amelia and Cumberland Islands, and it being desirable to make some sort of comparison between the combined discharges from Cumberland Sound and Amelia River, and the discharge at the entrance, the following methods were pursued to obtain such a check:

From the northern end of the Fort Clinch section an imaginary section was traced (see the large map) in a straight line over the shoals to a point on the southeastern end of Cumberland Island, about 500 feet south from the shore end of the north jetty.

Relative depths and distances were then picked from the map, and the section platted on cross-section paper. This is called Pelican Shoals section, and is shown on Diagram 20, D. Its length is 7,500 feet, and greatest depth at low water 13½ feet. Rod and mid-depth floats were run over the shoals at flood and ebb tide, more with a view of obtaining the direction than the velocity of the current, since it would be impossible, except in some seasons of exceptionally calm weather, to obtain anything like reliable measurements of velocity for a whole tide.

The positions and directions taken by the floats are shown on the large map, the arrows representing the paths actually taken by the floats. For the determination of the approximate discharge over the shoals and through the section, the following reductions were made, and were considered as giving the most reliable results to be obtained under the circumstances. Seven floats were run on ebb tide and seven on flood tide; when the float did not actually cross the line of the section the direction was projected on it and the float considered as acting at a certain point of the section, or at a certain distance from the angle in the section. See pages 94 to 98 of papers D. The floats were put in the water and allowed to run with the current for 5 or 6 minutes, and were located at every minute by two transits on shore, the signals being given from the small boat, which was always near enough to be in the field of view of each transit and not so near as to influence the velocity or direction of the float. Having platted the paths of the floats on the maps, the angle which the direction of the float made with the cross section was measured; and dividing the distance traveled by the time we get the velocity at time of observation.

There were then constructed curves giving the relative mean velocities during the tide, one for ebb tide at buoy No. 10 of Cumberland section, on April 6, and the other for flood tide for May 6 at Buoy 6 of the Fort Clinch section. Such curves were used because the ranges of tide on such days corresponded most closely to those of the days on which the floats were run. The curves are shown on Diagram 20 D.

The mean velocity being found for each tidal curve, the ratio of such mean with the velocity at each half hour of the tide was taken (see pages 95 and 96, papers D, and columns headed "Per cent. of mean velocity)." Then on the above-mentioned velocity curves were platted the rod and float velocities measured at time of observation. We then obtain a mean velocity for an imaginary float or rod curve by using the proportion: The mean velocity of observed curve is to the mean velocity of imaginary curve as velocity on observed curve at time of float observation is to float velocity at observed time. Multiplying the mean velocities so found by the relative percentages at the different half hours we get corresponding mean velocities for each float at those times. These velocities multiplied by the depth of water give at once mean discharges at time noted. These discharges were platted on cross-sectioned paper, vertical scale, 1 inch = 10 cubic feet per second, and horizontal scale 1 inch = 40 minutes. The areas of these figures give the total discharge for each float or vertical for the tide. These curves are shown on Diagram 21 D. The discharges were then resolved into equivalent discharges, acting at right angles to the section as previously explained in the reductions on the other sections. They were then reduced to mean range of tide by multiplying by the ratio of the range to the mean range, and finally being multiplied by the compartment width, we obtain total discharges for flood and ebb. See page 98, papers D.

The ebb discharge is greater than the flood by about $3\frac{8}{10}$ per cent. of the whole discharge. Naturally the measurement of discharge over the shoals is but very rough, and I inclined strongly to the belief that the ebb discharge should be somewhat less than the flood. The presence of the north jetty would have a tendency to retard the flood velocities, in fact to retard both flood and ebb, but since the measurements were taken south of the jetty, its influence would be decidedly more appreciable upon the floats run at flood tide than upon those run on the ebb, since the flood has been retarded before it reached the floats and the ebb would not be until after it had acted on floats. I have taken the duration of flood and ebb as being the same as through the Fort Clinch and south sections. There are however good reasons to believe that the flood acts much longer than the ebb; and

Digitized by Google

if such is the case for mean conditions, the relative discharges would be quite materially changed. See also pages 1581 of this report.

The following table gives the total discharges and mean velocities for each of the sections:

Section.	Discharge.		Mean velocities in feet per second.	
	Ebb.	Flood.	Ebb.	Flood.
	Cubic feet.	*Cubic feet.*		
Amelia River	1, 656, 851, 740 [5, 018, 892, 050]	1, 557, 239, 090	1. 835 [1. 885]	1. 729
Cumberland Sound	5, 618, 892, 050	4. 947, 565, 710	2. 111	1. 935
Fort Clinch	4, 645, 212, 920	3, 685, 735, 620	2. 223	1. 756
Pelican Shoals	2, 290, 171, 800	2, 203, 269, 500	1. 730	1. 738

The figures in brackets are obtained after deducting excessive rainfall.

The area of the tidal basin between the inside gauging sections is 70,000,000 square feet; this, multiplied by 6 feet, the mean range of tide, gives for the volume of the tidal prism corresponding 420,000,000 cubic feet. Now, if all our measurements were exact or thoroughly reliable, the sum of the discharges of the Fort Clinch and Pelican Shoals sections should equal the sum of the discharges of the Amelia River and Cumberland Sound sections plus the volume of the tidal prism inclosed between the limiting sections. As I consider the Amelia River and Cumberland Sound discharges as being in every way the most reliable; we will use those as a standard in the following comparisons:

The sum of the following ebb volumes—

	Cubic feet.
Amelia River	1, 656, 851, 740
Cumberland Sound	5, 618, 892, 050
Intermediate basin	420, 000, 000
Gives a total of	7, 695, 743, 790

This should equal the total ebb discharge through the Fort Clinch and Pelican Shoals sections. This discharge as measured is—

	Cubic feet.
Fort Clinch	4, 645, 212, 920
Pelican Shoals	2, 290, 171, 800
Making a total of	6, 935, 384, 720

which is within 9.9 per cent. of the total discharge, as measured by the inside sections. As explained later in the report, we can account for an excess in the ebb discharge from the sound of about 600, 000, 000 cubic feet. Such a correction would leave the discharge by the outside sections the least by about 2.3 per cent. Considering now the flood volumes, the sum of the following—

	Cubic feet.
Amelia River	1, 557, 239, 090
Cumberland Sound	4, 947, 565, 710
Intermediate Basin	420, 000, 000
Shows a total of	6, 924, 804, 800

and the flood volumes of—

	Cubic feet.
Fort Clinch	3, 685, 735, 620
Pelican Shoals	2, 203, 269, 500
A total of	5, 889, 005, 120

which is found to be 15 per cent. too small as compared with the discharge from the inside sections. This latter difference is quite large, and is too great to attribute to inadequate observations or reductions in the three sections proper. It is possible from the roughness of the observations on the shoals section for such a difference to be manifest, and the difference of 1,000,000,000 cubic feet between ebb and flood flow through the Fort Clinch section would indicate such to be the case, and still further

Digitized by Google

go to show that the flood flow over the shoals is greater than the ebb. I do not consider the ebb too great, but rather the flood too small.

The weakest point in either observations or reductions is undoubtedly that of the assumption that the discharge on the vertical measured is constant for the full width of the compartment, particularly when such widths are necessarily taken so great as from 700 to 900 feet. All things being considered, it would not have been too much to have expected differences from 10 to 12 per cent. There is a difference of 99,512,650 cubic feet between the ebb and flood discharges of the Amelia River section, the ebb being the greater. This difference, although too great, is approximately as it should be, and represents the fresh-water flow or surface drainage, and is about 6 per cent. of the total discharge. There is but little fresh-water flow proper entering into the Amelia River basin, and the difference must be due almost entirely to surface drainage, plus or minus the errors of observation and reduction. The Amelia River and its tributaries may be said to drain an area of about 30 square miles. With a mean yearly rainfall of about 50 inches, one-half of which may be considered as absorbed or evaporated, we would have a mean discharge for one tide, due to surface drainage, of about 2,490,590 cubic feet. Fifty per cent. for evaporation and absorption is possibly not too small, when we consider that such a large percentage of the drainage area is composed of swamp or overflowed land. However, as 50 inches of rainfall per year represents but 0.000238 feet (available for discharge) per hour, it is readily seen how materially even a light rain ought to affect the discharge. Take in illustration a rather heavy rainstorm, such as is apt to occur two or three times during the year, say 0.02 feet per hour for 12 hours; this would give a volume available for discharge of 100,427,040 cubic feet.

The factor of rainfall is an element in all discharge measurements of not only considerable magnitude, but also, unfortunately, of the greatest uncertainty, and results obtained may be distorted almost beyond belief by the action of such a factor. As to the uncertainty of the amount which becomes available for discharge, we are never or rarely able to determine how much of the drainage area is acted upon by the rainstorm; again, the amount of asorption or evaporation is very largely guesswork, depending as it does so greatly on the condition of the soil and vegetation at the time of the rainfall. Should the soil and vegetation be saturated, then almost the whole rainfall would be effective for discharge; *vice versa*, in an absorptive soil, after a long dry spell, possibly but little of the rainfall, and that in a very uncertain length of time, would find its way seaward; and still again the question as to how rapidly the rainfall would discharge itself would only be approximated to in the roughest manner, depending as it does on the physical characteristics of the country.

A record of rainfalls which occurred during the period of current observations was obtained from the signal service office at Jacksonville, Fla. With the exception of one or two unimportant occasions, these rains also extended over Fernandina and the adjacent country. In addition, there were several unimportant showers which fell at Fernandina and not at Jacksonville. Considering only such rainfalls as would likely affect observations on days which were used in obtaining final mean results, we find that the Amelia River discharge would be affected by the following rainfalls:

March 19, 0.15 inch.
March 24, 0.08 inch.
April 1, 0.07 inch.
April 2, 0.01 inch.

Considering the relative times of rainfalls and observations, I estimate the available amount of rainfall actually entering the observations as about 0.01 foot, which, multiplied by the 30 square miles of drainage area, would give but 8,363,520 cubic feet. This is less than 10 per cent. of the total amount of difference found between the total mean ebb and flood discharges. It, however, reduces this difference to about 5½ per cent. of the whole discharge, and this final difference can readily be placed to the account of faulty observations and reductions. How much the flood discharge is diminished by these slight rainfalls it would be about impossible to estimate, although the amount can hardly be appreciable.

On the Cumberland section there is a difference of 671,326,340 cubic feet between the ebb and flood discharges. This represents the fresh-water discharge from the St. Marys River and the surface drainage from the influenced area and is about 10 per cent. of the total discharge. The St. Marys River, Cumberland Sound, and other tributaries may be said to drain an area of about 1,400 square miles, of which but about 100 miles is drained by Cumberland Sound and tributaries. An annual rainfall of 50 inches gives a mean tidal discharge, due to such a cause of 112,202,510 cubic feet; this is but 2 per cent. of the total discharge. To account for the great difference between the observed difference of 671,326,340 cubic feet and the above calculated discharge due to a mean annual rainfall, let us suppose a rainfall of 0.02 feet per hour, and, considering the St. Marys drainage area only, suppose it

Digitized by Google

to last for 5 hours, it would give a volume, after deducting 50 per cent. for evaporation, &c., equal to 1,811,966,000 cubic feet. Owing to the great length of the river, possibly 150 miles to its source, but a certain portion of this could be discharged in one ebb tide of 12 hours. To obtain a rough approximation of what portion would be so discharged, we know that Woodstock, Fla., on the St. Marys, is at about the head of tidewater, and is about 75 miles from the mouth of the river; at Fort Moniac, on the north branch of the St. Marys, the water surface is about 100 feet above that at tidewater, and the distance not being much more than 60 miles, the fall on all the upper branches may be said to be considerable and causes quite large velocities. Considering the above and at the same time our current observations at King Ferry, it would be safe to say that taking the river from source to mouth the average mean velocity would be about 3 miles per hour. Thus we would obtain, on one tide, a discharge from about one-fifth of the total area. One-fifth of the above, 1,811,966,000, would be but 362,395,200 cubic feet, or a little over half the observed difference in discharges between ebb and flood flow from the sound section. The drainage from the sound basin would under similar conditions increase the above by about 26,000,000 cubic feet.

Now, the actual conditions were such during the period of our observations as to cause a very material increase in our ebb discharge due to rainfall. The Signal Service officer at Jacksonville, Fla., gives a total rainfall on the 14th and 15th of April of 3.52 inches. Nearly all of this fell during the day and night of the 14th and early morning of the 15th. This was shown by notes made by gauge-readers and other records on those days. One of the ebb tides which enter into our direct mean results was observed on the morning of April 15, between the hours of 7 and 1. I estimate that it would take 6 or 7 tides to discharge the bulk of this rainfall from the St. Marys, the maximum being reached about the third tide. It would not be safe to consider more than one-twentieth of the actual rainfall as being discharged on the ebb of the morning of the 15th; that is, one-half being considered as absorbed or evaporated and one-tenth of the remainder discharged on the second or ebb tide observed. One-twentieth of 3.52 inches over an area of 1,400 square miles would give a volume of 571,786,000 cubic feet.

One of the flood-tide measurements which enter directly into our mean was observed on April 20. This was, no doubt, lessened somewhat by being held back by the increased fresh-water flow from the St. Marys.

For the purpose of determining more directly what would be the discharge of the St. Marys under different conditions, a gauging of the river was obtained near King Ferry, Fla. King Ferry is about 50 miles by water from Fernandina; the mean range of tide during dry seasons is about 4 feet, and the duration of ebb about 7 and of flood tide about 5 hours. The velocities are not great during such seasons, the flood being particularly slow. Floats were run for ebb velocities at distances apart of 25 feet for the width of the river. For a cross section of the St. Marys at King Ferry, see Diagram 20 D.

From these observations and from information obtained from steamboat men, raftsmen, and the most intelligent business men, the velocities noted (see Diagram 20) were adopted as the most reliable to be obtained. The ebb discharge under ordinary stages of the river was thus found to be about 170,000,000 cubic feet and the flood about 64,000,000, the difference being approximately the fresh-water flow. Heavy rain storms do not cause great freshets in the St. Marys, the heaviest freshets only causing a rise in water level of about 2 or 3 feet. This is undoubtedly due to the fact of there being but little slope in the bottom of the lower portion of the river, and because the contiguous country is nearly all swamp, so that when the water gets above the banks, which are not much above high water as a rule, it spreads itself over a large portion of the drainage area.

With what are called ordinary freshets, such as are apt to last for a month or two at a time in the spring and fall, the river stands at about 1 foot above mean high water, and it seems to be well established that under such conditions or those of the most ordinary freshets the river at King Ferry runs ebb continuously.

The most reliable authorities gave the height of the river during March and April as being about 1 foot higher than at ordinary stages. A freshet of about this size was caused by the heavy rains of April 14 and 15. Under such conditions the mean velocity is about 3 feet per second and the discharge during 1 ebb tide about 598,700,000 cubic feet. Adding about 10 per cent. to this for the equivalent discharge from the sound basin would give a total of 647,570,000 cubic feet and still leave the small discrepancy between the ebb and flood mean discharges of the sound section of 23,756,340 cubic feet. This, however, might easily be attributed to natural faults in observations and reductions, being but about one-half of 1 per cent. of the total discharge. Again, no doubt, considerable discrepancy is due to the lessened amount of flood flow, it being held back both in time and amount by the action of the fresh-water flow. How great this effect would be it is almost impossible to say even with any degree of approximation.

Digitized by Google

It is interesting to make a short comparison between the discharge volumes obtained by the use of meters, on our survey, with such volumes as found by formulæ and from the tidal basin. Colonel Gillmore in his report of April 15, 1876, to the Chief of Engineers, considering a section between Amelia and Cumberland Islands, estimated the area of the tidal prism as 27 square miles; and considering the mean rise and fall of tide as 6 feet, he found the total ebb-tide discharge to be 4,546,369,080 cubic feet. This did not include any land drainage. Using Downing's formula $V=100 \times \sqrt{R \times S}$, and dividing the section into seven compartments and using the mean velocity obtained by the formula for each compartment, he found the ebb discharge to be 5,101,960,375 cubic feet, including the land drainage from the St. Marys tributaries. Our observations would give for a similar section about 7,550,000,000 cubic feet, or more properly about 6,950,000,000 cubic feet, since about 600,000,000 cubic feet should be subtracted from our discharges for excessive fresh-water flow, and the two methods give results differing by about 27 per cent. Colonel Gillmore estimated that about 28 per cent. of the whole volume escaped over the shoals. Our sections somewhat farther out show about 33 per cent. as going out over the shoals. He also estimated that about 38 per cent. of the flood volume came in over the shoal, while our figures give practically the same percentage.

COMPARISON OF ROD FLOAT AND MOTOR OBSERVATIONS.

On April 18 the ebb discharge of Amelia River was measured by means of rod floats; at the same time continuous meter observations were taken through the tide. From results so obtained we are enabled to compare the relative velocities and discharges, and at the same time discuss the relative field and office merits of the two systems. The field methods were as follows: The catamaran with the meter outfit was anchored at buoy No. 4, the middle one on the section. Two anchors were used, one fore and one leading aft. In addition to the observer there were two boatmen, and observations were taken from the one position throughout the tide. A base line 200 feet long, at right angles to the direction of the section, was measured on shore and an observer with a transit stationed at each end. Another observer with a transit was stationed about 2,000 feet down the river at a point on shore such as would give the best intersecting angles with the direction of the section. The floats consisted of 1¼-inch square poplar; they were weighted with lead weights of the same outside cross section as the rods and made fast to the bottom by means of a bolt and nut. Floats were run from 3 boats. The launch, manned with an engineer, wheelsman, and one man, ran a float 32 feet long past buoy No. 4; the Whitehall skiff, manned with 2 boatmen, ran a 35-foot float alternately past buoys Nos. 2 and 3; another skiff, manned with 2 men, ran 22-foot floats past buoys Nos. 5 and 6. Each float was marked with small colored flags indicating which buoy it was run past; the floats were put in the water, to one side or the other of the buoy, and from 50 to 100 feet above the upper transit line. They were picked up as soon as they had passed the lower transit line. As soon as they picked up a float the boatmen would pull in to and up along the shore, as a boat with a pole in tow could make no headway in the strong current of midstream. As a float approached the upper transit the observer raised a flag of a corresponding color and dropped it the instant it crossed his line; the observer at the lower transit did the same at the proper times. A boatman standing near the observer at the cutoff transit would call "flag up" or "down" (at the same time giving the color) to the observer, who would take the angle to the float on the down call, noting also the time as closely as possible as a check. A recorder with a chronometer stood half way between the two observers on the base line, and, they calling the "tick" as they dropped their flags, he would note the time and corresponding color of flags. In order that the floats might be run as frequently as possible and still not cause the times of upper and lower transits to fall too nearly together, the observer at the upper transit station signaled the boatman when and what float to run. Twenty-six floats were run near buoy No. 2, 23 near buoy No. 3, 41 near buoy No. 4, 26 near buoy No. 5, and 17 near buoy No. 6.

The velocity and discharge reductions are shown on pages 99 to 104, papers D. The observed velocities were reduced to mean velocities in the following manner: From the meter observations at buoy No. 4, on the same day a table of velocity ratios was made (see page 105, papers D); this table gives the ratio between mean velocities in feet per second for the *total depths* and mean velocities in feet per second for the total depth less a certain number of feet, the reduction in feet being from the bottom upward. Such ratios were formed for fifteen different times of observations, and for reductions in depths of 1, 3, 6, 9, 12, and 15 feet, the latter being about the limit of difference between the length of rod and depth of water. Then, considering the time of observation and the difference in feet between the depth and length of rod, the measured velocity was multiplied by its proper ratio and the true mean velocity obtained for the total depth. These ratios, as obtained at observations from one of the buoys, were applied to rods run at all the buoys, which, of course, was not strictly

Digitized by Google

proper, but considered far better than the application of any formula, since but a glance at the ratios shows that any known formula would be totally inapplicable. These corrected velocities were considered as forces and resolved into corresponding velocities acting at right angles to the section, the paths of the floats having been previously platted to a convenient scale, thus determining the observed velocities and the directions. The distances from a fixed point on the section to the point where the float crossed it were scaled from the plat, and the mean low-water depths taken from the platted cross section. These depths were a mean between the depths on the upper and lower cross sections. This was considered more reliable in view of the great variation in depths between the two sections. The mean low-water depths, after having the proper gauge correction applied, were multiplied by the corresponding mean velocity and the discharge in cubic feet per second on the vertical obtained.

These discharges being platted on cross-section paper and a curve constructed through the points found, then the areas of the figures gave the total discharge of the float vertical for the tide. These curves are shown on diagram 22 D.

The mean distance from the shore of each set of floats was taken as the float position, and the compartment widths taken correspondingly. See diagram 6 D for sections of floats and compartment widths. The final reductions for loaded rod discharge are shown on pages 106–112, inclusive, papers D, a comparison being made on page 112 between the discharges by loaded rods and metres. The total discharge of the section as obtained from rod measurement is found to be slightly smaller than that obtained by metre observations, the loaded rod discharge being 97 per cent. of the metre discharge. The best discharges on verticals to compare are those at buoy No. 4 and rod position No. 4, since the float position is but 20 feet east of buoy No. 4, and in but 1 foot less water. The rod discharge on vertical No. 4 is seen to be 88 per cent. of the discharge on the vertical on buoy No. 4, and if these discharges are made proportional to the relative depths we find that with equal depths the discharges differ by about 10 per cent. The rod and metre discharge curves are shown plotted, one over the other, on diagram 8 D. A comparison of the relative discharges near the beginning or ending of the tide can not be made from the diagram since those portions were simply sketched in to complete the curves. The greatest differences are noticed when the velocities are greatest, when for the space of about 40 minutes the metre discharge is about 10 per cent. greater than the rod discharge. Since the depths are practically the same these curves will equally well represent mean velocities for the sake of comparison. As to field methods, the choice should undoubtedly be given to metre observations; so many observers are required for rod work that it becomes not only cumbersome but expensive. One point not to be overlooked in rod measurement is that the velocity measured is not that acting at the section proper, but rather the mean of all velocities acting on the rod from the time it is placed in the water until it passes the lower "transit." Except in uniformly constructed flumes and with a constant head of water, the velocities can not be considered constant for any but "unit" length of stream. Whereas the metre observations give the actual velocities only existing in the plane of the cross section, so that it is plainly not strictly legitimate to compare the two systems, since, more strictly speaking, the cross section of the stream to be used in connection with the rod measurements should be a mean of a great number of cross sections taken from the lower transit up at least so far as where the floats were put in the water, if not still higher up.

A very strong point against the use of rods in tidal streams is that the velocities are constantly varying and that they do not vary at all proportionally to any known cause or element. For example, at one stage of the tide we may find strong velocities for about half the depth, and for the other half almost slack water; again, at another stage the velocity may be almost uniform from top to bottom; and there is no uniformity about such variations, as they are altogether different for different tidal conditions. Consequently it would be impossible to apply any correction for rods which did not reach closely to the bottom. With metres we are enabled to obtain a much more continuous set of observations, and have the great advantage of obtaining at the same time the velocities at any measured depth, whereas rods give but the mean velocity, and separate observations would have to made with submerged floats to obtain bottom or mid-depth velocities, and as such velocities are always wanted the obtaining of them must necessarily curtail the number of mean velocities obtained by rod measurement. Submerged floats are unreliable at the best; we are never sure as to their actual submerged depth, or whether they remain constant. When the suspending surface float is made a minimum, to influence as little as possible the submerged float, then the submerged float having almost the same specific gravity as the water will be very easily influenced by vertical currents and eddies, such as must exist in streams having rough bottoms. There is but little difference between the two methods in the amount of office work necessary for discharge reductions, but the amount of general information which is available from the metre observations is largely in excess of that obtained from rods.

Digitized by Google

BORINGS.

Three borings were taken on the bar near the east end of the south jetty. The pilot boat *Robt. H. Cowan* was used on this work. The first attempts made were not successful; a 2-inch well auger was used inside of a 2½-inch pipe, both pipe and auger being fitted in sectional lengths so as to enable the apparatus to be used at any depths; the idea was to sink the pipe slowly by removing the material from the inside in the same manner as a well would be bored. Owing to our inability to hold the pilot boat still, we were not able to satisfactorily handle the apparatus; in efforts to do so the pipe and auger were twice broken in two, so that finally, after many discouraging efforts, the attempt was given up. There is quite a swell running at all times over the bars, and it is only in the calmest weather and at slack high water that the sea would be calm enough to work with any sort of outfit in such localities. With three heavy anchors out and lines drawn taut there was still always play enough in the lines to enable the pilot boat to move a few feet; this would cause the boat to run against the pipe, and after the pipe was down a few feet, so that it would not give sideways, the natural result was that, by the action of some unusual swell, the pipe was bent over or broken off. Attempts were made to use small boats, but the pipe and auger could not be used from them. Finally the following method was adopted: A Blake hand force pump, having an 8-inch cylinder and 4-inch stroke, was used and water forced through a 1-inch gas pipe, the pipe being made in sections to enable a ready extension. The stream of water forcing the material away from the end of the pipe or more thoroughly saturating it the pipe was forced down by hand. The pump was rigged on the deck of the pilot boat and could be worked by 2 or 4 men at once, thus enabling us to bring a pressure on the cylinder head of about 65 pounds to the square inch. A section of rubber hose led from the pump to the pipe, so that the pipe could be sunk from a small boat a short distance away, thus running no risks of the pipes being broken by contact from the pilot boat. The greatest thickness of material penetrated by this method was 7.2 feet; of course no specimens of materials were obtained, but by the sound of the material against the pipe, and by the different sensations of touch as the pipe descended, a very good knowledge of the nature of the material could be obtained.

The location of the borings is shown on the large map. No. 1, which is a few hundred feet southwest from the outer end of the jetty, was taken in 12.3 feet of water; the first 4 feet penetrated was composed of rather coarse sand, slightly mixed with fine shell, we then met a layer about one-half of a foot thick of fine compact coquina, then again about 2.7 feet of the coarse sand; here the pipe refused to go any deeper, owing not to the fact of having encountered any harder material, but rather because of the excessive friction of the material already passed through against the sides of the pipe. Boring No. 2 was located about 400 feet northeast from the end of the jetty and was in 12.7 feet of water. The material encountered was first about 3.5 feet of the usual coarse sand, and then a fine compact sand which could be penetrated only a few inches, and which gave a clear ringing sound when the pipe was forced down hard against it. The total depth reached was about 3.6 feet. Boring No. 3 was located about 300 feet due east from the end of the jetty and in 11.2 feet of water. A depth of about 2.5 feet was reached, the material being all hard compact sand.

The depths in the vicinity of where the borings were taken do not seem to have changed materially for many years, say since 1856, though between 1843 and 1856 there was quite a noticeable shoaling in connection with a seaward movement of the bar. Since 1856 the bar just north of the east end of the south jetty has moved seaward, as indicated by the 18-foot contour, about 1,400 feet, while the water on the bar has deepened from 7 or 9 feet to from 13 to 14 feet. The character of the borings would indicate that the bottom would form a good foundation for any jetty or similar construction, while it seems also apparent that the material is of such a nature as will readily admit of its being acted on by scour. The pilots of the vicinity say that the bottom on all shoals and bars is much harder on flood than on ebb tide, although not able to offer any explanation for such a condition, saying they simply judge from the manner in which their anchors hold.

There seems to be a steady growth eastward of Amelia Island and almost a proportional eating away to the westward of Cumberland, amounting, in the latter case, to about 400 feet since 1869. Appearances seem to indicate that within certain limits the shoals, particularly the north shoals, are of a shifting nature, that any storm or unusual tide with a heavy sea will change them quite perceptibly. This was illustrated plainly when we were running levels from Amelia Island to the boilers and Cumberland Island.

Pieces of iron gaspipe, to act as turning points, were put down at low water on certain shoals; when first put down they were on shoals so as to be from one-half to 1 foot of water; it was noticed several days later, when the tide was within half a foot of the low water of the day the pipes were put down, that the pipes were in from 2 to 3 feet of water. It was noticed that sand stirred up in walking over the shoals would be carried along several feet with the tide before being deposited. It seems but natural that the conformation of such shoals should be changed materially

Digitized by Google

under the action of breakers and tide combined; this action being much the same as can always be noticed in the surf along shore, the breakers stirring up the sand and other material, the strong under-tow or back flow drawing it seaward at the same time that the tide gives it a movement of translation.

It was the endeavor to make both field and office work as practical as possible, using such an amount of refinement in the office, mapping, and reduction work as would be commensurate with the accuracy or reliability of the results from the field gears and methods.

The progress of the survey was reported to you trimonthly on forms provided for that purpose. The steam launch was of the greatest service on the survey, not alone in taking soundings but in general survey work.

The following statement gives her running expenses for the time she was on the survey:

Engineer, salary, 4½ months, at $75	$318.75
Wheelsman, salary, 4½ months, at $35	148.75
Water, 6,375 gallons, at ½ cent	21.25
Coal 10½ tons, at $7.50	78.75
Kerosene oil, 4 gallons, at 20 cents	.80
Lard oil, 4 gallons, at $1	4.00
Cylinder oil, 4 gallons, at 80 cents	3.20
Soda 20 pounds, at 5 cents	1.00
Waste, 8 pounds, at 12½ cents	1.00
Paint, 5½ quarts, at 50 cents	2.75
Incidental repairs	5.70
	585.95

Including the runs to and from Savannah, the total number of miles run was 2,007 When we consider the additional time it would have been necessary to have retained surveyors and other assistance on the work, had a small boat and crew been used from which to take the soundings, we at once see that the launch was a decidedly economical element.

The preparation of plans and the report on this survey has been interrupted and delayed by various surveys, examinations, and reports which it was necessary to work up more immediately. Such work consisted in the preparation of maps, diagrams, etc., of the survey of harbor at Brunswick, Ga.; survey, plans, etc., of Jekyl Creek, Ga.; survey, plans, and report on military reservation, Amelia Island, Fla.; annual examinations and reports of Cumberland Sound, Jekyl Creek, and Brunswick, and completion of survey of harbor at Brunswick, Ga.

The survey was completed and the party disbanded on the 28th of May, 1889.

Many of the satisfactory results obtained on this work are due to the efficient services of my assistants. In this respect I can not too highly recommend Mr. George W. Brown, assistant engineer, who had charge of the gauging operations; Mr. John L. Van Ornum, surveyor, who took the offshore current observations and was of great service on the general survey work, and also Mr. George Gammont, leadsman, who, in addition to being an extremely useful all-around man, always manifested an interest in the work and a desire for its success. Mr. George F. Riggs, surveyor, was also of great service in the various duties he was called upon to perform.

The following plans, papers, and books, accompany this report:*

Tables and papers A, 16 pages.
Tables and papers B, 26 pages.
Diagrams B, 13 sheets.
Tables and papers C, 30 pages.
Diagrams C, 13 sheets.
Tables and papers D, 112 pages.
Diagrams D, 24 sheets.
One large map 4½ feet by 8 feet, scale 1 inch=400 feet.
One roll-record of self-registering gauge at boilers.
Eleven note books, soundings.
Eight note books, gauging and currents.
Eight note books, transit notes.
Twelve note books, tide-gauge records.
Nine note books, cross-section notes.
Four note books, levels and miscellaneous.

Very respectfully, your obedient servant,

MILNOR P. PARET,
Assistant Engineer.

First Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

* Omited.

Digitized by Google

REPORT OF THE BOARD OF ENGINEERS ON IMPROVEMENT OF CUMBERLAND SOUND, GEORGIA AND FLORIDA.

THE BOARD OF ENGINEERS,
New York City, March 11, 1891.

GENERAL: In accordance with the instructions contained in your indorsement of November 25, 1890, upon the project of First Lieut. O. M. Carter, Corps of Engineers, for the expenditure of the appropriation of September 19, 1890, for Cumberland Sound, Georgia and Florida, The Board of Engineers has made a full investigation of the condition of the works of improvement in progress at that place, and has the honor to submit the following report thereon:

After carefully examining, in company of the District Engineer, Captain Black, the similar works now under construction at the mouth of the St. Johns River, and one member having obtained information as to the progress to date of those at Charleston, S. C., the Board visited Cumberland Sound in company with the District Engineer, Lieutenant Carter, on February 3 and 4, and inspected the works in detail. It then proceeded to the office at Savannah, and examined the maps and records on file bearing on the subject. Lieutenant Carter was afforded every opportunity to express his views, and gave much information to the Board.

The improvement of this harbor entrance by jetties was discussed in some detail by General Gillmore in his Annual Report for 1876. His final project, which was approved and is now in process of execution, is contained in his Annual Report for 1879. A summary of work done to date is contained in the Annual Report of the Chief of Engineers for 1888, on page 1054.

The area of the tidal basin is about 27 square miles. The tidal inflow and outflow between Cumberland Sound and tributary waters on the one hand and the ocean on the other traverses a deep channel between Amelia Island and Cumberland Island. Lieutenant Carter's "Fort Clinch Section" crosses this channel nearly at right angles, starting at a point about 4,000 feet eastward of Fort Clinch, and following a line running nearly north and south. This section extends from Amelia Island to Pelican Shoal, and has a width of 3,140 feet, a midtide cross section of 95,820 square feet and a maximum depth of 49 feet. At mean ebb outflow the mean area of cross section is 94,222 square feet, the corresponding mean ebb velocity being about 2 feet per second; at mean flood inflow these quantities are 97,676 square feet, and 1.8 feet respectively. These figures result from a set of gaugings recently made under the direction of Lieutenant Carter, and they do not differ materially from General Gillmore's original assumptions.

Lieutenant Carter's "Pelican Shoal Section" begins at the northern end of this Fort Clinch Section, and extends on a straight line along the shoal to Cumberland Island. The width is about 7,500 feet, and the sectional area about 55,000 square feet. The north jetty lies to the northward, nearly parellel to this section and but a short distance from it.

Across these two sections passes all the tidal flow that need be considered. The entire ebb volume, as reported by Lieutenant Carter, is about 5,280,000,000 cubic feet. His entire flood volume does not differ materially from these figures.

The deep channel between Cumberland and Amelia islands extends

Digitized by Google

seaward half a mile or more past the latter, and has continued essentially unchanged for many years. At its seaward terminus occurs the pendulum-like shifting of channel so common on this coast. The naturally straight course across the bar is slowly deflected southward by the encroachment of sand coming from the north, until its increasing length becomes too great for maintenance, when, usually in some storm, the outflowing tide again breaks a new channel straight across the bar, and the same cycle of changes is resumed.

The changes of channel of this character which have occurred at the entrance to Cumberland Sound are approximately known from the recorded sailing courses, and they are suggestive. In 1843 the survey showed that there existed two well-marked channels, one leading eastward across the bar and the other southward, in a direction approximately parallel to the shore of Amelia Island. From the existence of a double channel at this date, it appears probable that the easterly route had been opened quite recently. At the next record, in 1855, the southern channel had disappeared and the eastward channel had shifted considerably toward the south. A gradually progressive southerly movement of this channel continued as shown by the records of the years 1856, 1857, 1869, 1874, and 1876; but at the next record, in 1879, this channel had disappeared and a new one had broken out far to the northward. The period of the cycle in this case thus appears to have been about 25 years. Since 1879 the channel has been slowly working southward again, as appears from the records of 1882, 1883, 1885 and 1890. At the present time, therefore, the conditions existing at the bar conspire to cause a decided tendency toward a southerly movement of the channel.

The natural depth on the bar at mean low water has varied from 11 to 12.5 feet at mean low water, and the works of improvement have not yet progressed far enough to cause any well-marked change for the better. The mean rise and fall of the tide is about 6 feet.

The progress of jetty construction has been the following: The north jetty was begun in June, 1881, and work on it ceased in March, 1883. The length of the foundation course was 7,372 feet, with a second course 1,366 feet long where Cumberland Channel was crossed. The top of this north jetty now averages about 3 or 4 feet below mean low water, except near the shore end where it has been raised above that plane. Pelican Shoal forms a kind of natural extension reaching to the bar, but it is subject to erosion by currents and can not be trusted to perform useful contraction work.

The south jetty abuts on Amelia Island at a point about 2,500 feet outside of the eastward end of the north jetty as now constructed. It was begun in May, 1882, and work has continued, with long intermissions from lack of funds, up to the present time. It is now about 10,000 feet long, of which about 1,000 feet at the shore end have been raised above the plane of mean low water. The next 3,000 feet are about at the level of that plane. The remainder consists of a foundation course only lightly covered with stone. At mean low water it is submerged to a depth of about 12 or 13 feet.

The present condition of this improvement can not be regarded as satisfactory, especially in view of the fact that the funds now available, or likely soon to become available, are insufficient to execute work required by existing conditions to be done with great promptitude. This is apparent from the following statement:

Digitized by Google

The north jetty in no degree checks the natural encroachment of the sand advancing from north to south upon the channel across the bar. This movement, as shown above, has continued since 1879, and although perhaps checked a little by the incomplete south jetty, now threatens to shoal up the narrow passage still remaining north of it, and thus to compel the whole flow to cross the jetty. The survey of June, 1890, showed that the width between the jetty and the northerly 12-foot curve had been reduced from 900 feet in 1889 to about 400 feet. The proposed locus of the deep-water entrance is thus choked up by an immense mass of sand which already throws a strong current over the outer extremity of the south jetty; or rather, over the single foundation course which represents a jetty in this vicinity. Moreover, an extensive southerly pocket exists in the southerly 12-foot contour which crosses the line of the jetty still further shoreward, and this may assist the navigable bar channel to desert the desired route entirely.

But this is not all. A tendency to open a northerly or swash channel across Pelican Shoal, at a point about 4,000 feet in front of the present end of the north jetty, has recently been developed. Here the 12-foot contour has formed a large pocket and nearly joins the outer 12-foot contour. This suggests new and dangerous possibilities, which call for a prompt extension of the north jetty. Lieutenant Carter estimates that the funds now available will permit a 6,000-foot extension of the foundation course, consisting of a 100-foot mattress covered with 12 inches of stone. This application is recommended by him and approved by Colonel Craighill, the Division Engineer, and this Board concurs in the recommendation. No further raising of the south jetty can safely be undertaken until this is done.

The Board, after consideration of all the conditions existing at Cumberland Sound, does not advise any radical change in the general location of the jetties as originally proposed. It does not think that a single jetty on the north side of the channel, curving gently to the south, would secure the deep water needed; but is of opinion that two jetties will be necessary, and that they should reach deep water by the shortest line. Such jetties, in case shoals form in front of them, will require a less amount of extension than jetties which curve toward parallelism to the shore. In time of fogs and heavy weather straight jetties would give an entrance more easily navigated than curved ones. The idea that such a curved channel conforms to the natural requirements of the site and opposes the action of the natural forces less than any other, is believed to be fallacious, because, when the tendency to a southerly movement of the sand is removed by the construction of a north jetty raised to high water, the conditions will be materially modified, and there will remain little or no tendency in the channel over the bar to shift southward.

The width between jetties at the bar and their exact location in this vicinity were left somewhat indefinite in the original project. General Gillmore's discussion (1876) indicated 4,000 feet as requisite with high jetties to give a depth of 20 feet at mean low water; but his final project (1879), which contemplates low jetties, specified from 3,000 to 3,500 feet. The location given on Lieutenant Carter's blue print accompanying his report indicates, as his understanding of the approved project, 2,700 feet.

The width at the entrance is a matter of great importance. In view of past experience on works of this character on this coast, although none of them have yet progressed far enough to afford positive data,

Digitized by Google

it seems prudent to locate the constructions in a manner to render it possible to resort to high jetties if necessary. But this demands enough width at their outer extremity to permit a tidal inflow sufficient to maintain the natural tidal prism nearly undiminished. According to Lieutenant Carter's figures the mean discharge between Cumberland and Amelia islands during ebb is about 240,000 cubic feet per second, and the mean ebb velocity in the Fort Clinch section is 2 feet per second. If, then, the whole outflow were confined to a deep section at the site of the Fort Clinch Section, of similar form and with the same mean velocity of 2 feet during ebb, a cross section of 120,000 square feet would be needed. With jetties 3,900 feet apart at their outer ends, and a mean depth of 23 feet at mid-tide between the jetties, the section would be but 90,000 square feet. A reduction of section from 120,000 square feet at the gorge to 90,000 square feet between the ends of the jetties would be large; and any less width would probably result in excessive depths or in a considerable reduction of tidal volume.

These figures indicate that to provide for the contingency of a resort to high jetties the works should be located so as to leave a channel of at least 3,900 feet between them. Should it be found during the construction that lower jetties will afford sufficient depth, it will not be necessary to raise the south jetty throughout its whole length to high water; and any narrowing of the water way which may become desirable can be obtained by spurs. A width too great can thus be corrected readily, but a width too small will entail the necessity of a removal and reconstruction of work done, and this at no inconsiderable expense. For these reasons the Board considers that the projected width should be established at 3,900 feet.

It is probable that the north jetty may have to be raised ultimately to high water to prevent sand moving south over it into the channel. The ultimate section should be composed of a mattress of log foundation and a hearting of small stone covered by heavier stone. The latter in going outward should increase in weight from 1,000 pounds to 5 tons as the low-water depth increases from zero to 12 feet. Beyond this depth still heavier stones should be used. The side slopes should be as steep as such stones will stand. A width on top of 10 feet at high water is sufficient.

The Board has indicated upon an accompanying copy* of Lieutenant Carter's blue print, marked "proposed revision of project," the position of jetties conforming to these views. It is to be regretted, since the north sand bank has moved so far southward, that the existing south jetty is located so far northward; because this not only compels the construction of the north jetty upon a difficult location, but also leaves an immense mass of sand in the proposed channel to be removed by dredging or otherwise. The only alternative, removal and reconstruction of a large part of the south jetty appears however, too costly to be advisable.

The general order of the work under future appropriations should be the following, considerable discretion being left to the engineer in charge, to meet new conditions as they arise: The construction of the north jetty should be first undertaken, and it should be raised to a height sufficient to effectually stop the sand movement southward; then

*Not printed.

Digitized by Google

the south jetty should be raised and extended, as may be found necessary to obtain the desired depth over the bar.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President of the Board.
C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Colonel of Engineers.
G. L. GILLESPIE,
Lieut. Colonel of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 13, 1891.

Approved.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

N 10.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECKS IN SAVANNAH HARBOR.

As recommended by the Chief of Engineers, the Assistant Secretary of War, under date of April 23, 1890, made an allotment of $100 from the original indefinite appropriation for removal of wrecks, etc., to enable Lieut. O. M. Carter, Corps of Engineers, to make an examination of certain wrecks obstructing the navigation of Savannah Harbor.

This examination was made and under date of August 23, 1890, the following report was made to the Chief of Engineers:

UNITED STATES ENGINEER OFFICE,
New York, N. Y., August 23, 1890.

GENERAL: I have the honor to submit the following report of an examination of the sunken vessels or craft obstructing or endangering navigation in Savannah River and Harbor, with a view to their removal.

The sum of $100 was allotted for the purpose of making the examination, which was done during the month of July, 1890, the above amount being expended.

There were found in the channel, or sufficiently near it to endanger navigation, the wreck of three steamers, three sunken barges or flats, some pieces of crib work, and a pile of ballast.

The wreck of the steamer *Habersham* lies in Wreck Channel, near the fourth spur of the Fig Island jetty, about 1,200 feet below the Savannah, Florida and Western Railway wharves. She was a stern-wheel steamer, 135 feet long, 25 feet wide, of 200 tons burden, had oaken timbers and pine plank 3 inches thick. She was built by H. F. Willink, of Savannah, was blown up and sunk near Screvens Ferry in 1862, and was removed to her present position shortly after the close of the war, her machinery having been taken out. She is deeply imbedded in the sand, and the depth of water around her varies from 8 to 15 feet at mean low water. Some pieces of the steamer *Milledgeville* lie in the vicinity of the *Habersham*, one piece being

Digitized by Google

ledged against her. A sunken barge lies alongside the *Habersham*. It is estimated that $2,500 will be necessary to break up and remove the wreck of the *Habersham* and the barge, and about $900 for the other pieces of wreckage in that vicinity.

About 500 feet above the *Habersham* is some wreckage that seems to be fragments of crib work sunk during the war. The water surrounding it is from 7 to 18 feet in depth at mean low water. The sum of $1,000 is estimated as necessary for its removal.

Five hundred feet below the *Habersham* is a sunken sand flat right side up in about 10 feet of water. This flat is about 55 feet long and 15 feet wide. It is estimated that it can be removed for about $300.

Opposite the upper end of the new Central Railroad wharf and about 200 feet from shore is a sunken obstruction that seems to be a barge filled with brick. The barge is heavily timbered and ironed, is firmly imbedded in the sand, and lies in from 6 to 8 feet water. The cost of removing this obstruction is estimated at about $1,700.

Just below the city water works and near Hammond, Hull & Co.'s wharf, lies the wreck of the steamer *General Lee*. In the custom-house records of December 21, 1863, she is described as a stern-wheel steamer, 139 feet long, 27 feet beam, 4.6 feet depth of hold, and 250 tons burden; built at Jacksonville, Fla., in 1859. She lies near the shore in about 10 feet of water, and can be removed at an estimated cost of about $1,800.

In the "Bight," what has hitherto been called a wreck, was found upon examination to be a pile of rock, probably ballast thrown out by some vessel. The top of the pile is 4.5 feet below low-water level, and the depth of water surrounding the pile is from 20 to 24 feet. It is estimated that this obstruction can be removed by dredging for the sum of $450.

The shape and position of the obstructions described above are shown on the appended sheets,* lettered A to K inclusive.

In all, the sum of $9,570 is asked to be allotted for the purpose of removing sunken vessels and other craft obstructing or endangering navigation in Savannah River and harbor. Should the dredging necessary to remove the shoals caused by these wrecks be included in the work, the above estimate should be increased to $11,270.

I respectfully recommend that the sum of $11,270 may be allotted for the execution of the work herein described.

Summary.

Sheet.	Name of wreck.	Location.	Estimated cost of removal.
A and G	Steamer *Habersham* and sunken barge.	Wrecks Channel	$2,500
A and G	Steamer *Milledgeville*	do	900
B and G	Crib work	do	1,000
C and G	Sand flat	do	300
D and H	Flat loaded with brick	Vale Royal Wharf	1,700
F	Steamer *General Lee*	Below water works	1,800
E and K	Ballast Pile	In the "Bight"	450
			8,700
Supervision and contingencies, 10 per cent			870
			9,570
Dredging, if included in this work			1,700
Total, to include dredging			11,270

Respectfully submitted.

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

These wrecks being deemed obstructions to navigation, it was recommended by the Chief of Engineers, under date of September 9, 1890, that if not removed by the owners after the usual notice, that they be removed by the United States under the provisions of section 4 of the

*Not printed.

Digitized by Google

river and harbor act of June 14, 1880, at an estimated cost of $7,975, and that the sum mentioned be allotted for the purpose from the indefinite appropriation for the removal of wrecks, etc., provided for by the section referred to.

This recommendation was approved by the Secretary of War September 13, 1890.

The Chief of Engineers was of the opinion that the indefinite appropriation for the removal of wrecks was not available for the removal of crib work, ballast, and for executing dredging, and therefore the estimated cost of those items was deducted from the sum of $11,270, asked for in report of August 23, 1890.

The notice required by section 4 of the river and harbor act of June 14, 1880, to all persons interested in the wrecks proposed to be removed, was given by advertisements in the local newspaper, and proposals for removing the wrecks were invited. No action having been taken by the owners, the proposals were opened December 10, 1890. An abstract of the proposals received will be found in the appended table.

The following is report of operations in full:

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., March 6, 1891.

GENERAL: In compliance with Circular No. 3, Headquarters Corps of Engineers, U. S. Army, Washington, D. C., May 29, 1889, I have the honor to submit the following report of the removal of certain wrecks from the Savannah Harbor, Georgia.

A report of an examination made to determine the cost of removing the wrecks or obstructions of (1) steamer *Habersham* and barge, (2) steamer *Milledgeville*, (3) steamer *General Lee*, (4) sand flat, (5) flat loaded with brick, (6) crib work, (7) ballast stone, was submitted by me on August 23, 1890, to which I respectfully refer for details.

The removal of the first five obstructions named was authorized by the Acting Secretary of War on September 13, 1890, and the sum of $7,975 was allotted for that purpose. Formal bids were opened December 10, 1890, and on December 15, 1890, the contract for the removal of these obstructions was awarded to Mr. Charles W. Johnston, of Lewes, Del., for the sum of $3,900. The contract was signed January 24, 1891.

Work was begun by Mr. Johnston on January 12, 1891, and completed on February 12, 1891.

The wreck near the Central Railroad wharves, originally supposed to be that of a brick flat, was found to be that of a small sailing vessel loaded with small round shot, from 6 to 10 pounds in weight. The wreck of the *General Lee* had been previously removed by private parties to open a channel to Hammond, Hull & Co.'s wharf.

All of the obstructions were removed by breaking them up with charges of high explosives and then removing by hand the pieces. The outfit employed was (1) a small sloop, (2) two small row boats, (3) diving outfit complete. Between 2,500 and 3,000 pounds of Atlas powder were used, resulting in the complete destruction and removal of the obstructions.

During the removal of these wrecks it was found that the obstruction supposed to be crib work and which could not be removed from the appropriation for the removal of wrecks was in reality a sunken barge. Authority to remove this was obtained from the Chief of Engineers on February 6, 1891, and on February 14, 1891, in response to circular letter dated January 31, 1891, the contract for its removal was awarded to Mr. Charles W. Johnston, of Lewes, Del., for $945, he being the only bidder and his bid being considered reasonable.

Work was begun on February 16, and completed February 18, 350 pounds of Atlas powder being used.

In addition to the usual inspection, an examination was made by Mr. W. A. Dayton, inspector, using Mr. Johnston's diving outfit. All portions of the wrecks had been found to be removed.

All of Mr. Johnston's work was quickly and satisfactorily executed.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Digitized by Google

Abstract of proposals for removing wrecks in Savannah River, Georgia, opened December 10, 1890, by First Lieut. O. M. Carter, Corps of Engineers.

No.	Name and residence of bidder.	Amount.
1	Charles C. Ely, Savannah, Ga	$6,950
2	Savannah Dredging Company, Savannah, Ga	10,000
3	John C. Smith, Charleston, S. C	7,700
4	Chas. W. Johnston,* Lewes, Del	3,900

*Bid recommended for acceptance, he being the lowest responsible bidder for the best and most suitable service. Amount available, about $7,250.

WRECKS OF THE TUG COLUMBUS AND THE STEAMER NASHVILLE.

Under date of November 30, 1890, Mr. Paul T. Haskell, of Savannah, Ga., reported that the wrecks of the tug *Columbus* and the steamer *Nashville* in Ogeechee River, Georgia, dangerously obstructed the navigation of the stream, having up to that date been the cause of three disasters.

An allotment of $150, with which to make an examination of these wrecks, was asked for and granted. The examination was made, and the following is the report in full:

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., December 13, 1890.

GENERAL: I have the honor to submit the following report of an examination made by me on the 6th instant of the wrecks reported by Mr. Paul T. Haskell, Savannah, Ga., in his letter dated October 30, 1890 (a copy of which was transmitted to the Department with my communication of the 6th ultimo) as being obstructions to the navigation of the Ogeechee River, Ga.

The steamer Nashville is situated in the bend of the Ogeechee River, just above the site of old Fort McAllister. It is on a sand bank that goes dry at low water, is at least 300 feet from the river channel, and in no manner obstructs the navigation of the river.

The tug Columbus (of which it is asserted that it was at one time used as a tender to the Nashville) was sunk when Fort McAllister was evacuated in 1864. The remains of her lie about 5 miles, by river, above the position of the Nashville, and at a point indicated on the following sketch.*

A detailed examination of this locality was made by me, and the river in the vicinity carefully dragged to discover the position of the wreck. A depth of about 10 feet at low water was found over it. I am informed that a portion of the machinery of the wreck, which formerly rose above the depth given above, was removed some 2 years ago by wrecking parties, who, at the same time, removed considerable and valuable portions of the wreck of the Nashville. The obstruction (tug Columbus) as it now stands is not, in my opinion, a sufficient obstruction to navigation as to warrant the expenditure of any money in its removal. There is now a clear channel of sufficient width and depth for all of the needs of navigation between the wreck and the concave shore.

Very respectfully, your obedient servant,

O. M. CARTER,
First Lieutenant, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

AMOUNT AND IMPORTANCE OF NAVIGATION OF OGEECHEE RIVER.

Vessels engaged in commerce.

Barges	15
Sailing vessels	2
Tugs	2
Fishing boats	100

* Not printed.

Digitized by Google

COMMERCIAL STATISTICS.

Year ending June 30, 1890.

Name.	Quantity.	Value.
Rice	57,000 bushels	$50,725
Timber	10,000 feet	120,000
Fire wood	500 cords	1,000
Naval stores (value estimated)		5,000
		176,725

N 11.

PRELIMINARY EXAMINATION OF YELLOW RIVER, GEORGIA, FROM THE RAILROAD BRIDGE NEAR COVINGTON TO THE OCMULGEE, WITH A VIEW OF OBTAINING A STEAMBOAT CHANNEL OF FIVE FEET DEEP AT MEAN LOW WATER.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., March 11, 1891.

GENERAL: In accordance with the requirements of section 17, of the river and harbor act of of September 19, 1890, and of instructions from the Chief of Engineers, dated September 20, 1890, I have the honor to submit herewith my report upon the preliminary examination of the "Yellow River, Georgia, from the railroad bridge near Covington to the Ocmulgee, with a view of obtaining a steamboat channel of 5 feet deep at mean low water."

The examination was made under my direction by my assistant, Lieut. Thos. H. Rees, Corps of Engineers, U. S. A. His report, which has just been received, is appended hereto.

The Yellow River rises in the northern part of Georgia and flows through the red clay hills in a direction a little east of south, to form, with the South River, at a point 21.5 miles by river below the Georgia Railroad Bridge, the Ocmulgee River.

The basin of the Yellow River is an excellent farming country, and is in a good state of cultivation.

The only timber consists of second growths of pine, oak, gum, etc.

The principal product of the section of country adjoining the river is cotton, although grain, potatoes, etc., are also produced.

Between the Georgia Railroad Bridge and Cedar Shoals there are said to be numerous deposits of excellent molding and building sands, of terra-cotta clay, of red ocher, and of granite.

The fall of the river at various shoals was measured with a hand level. The slope in the pools is estimated.

Between the Georgia Railroad Bridge and Cedar Shoals, a distance of 5.7 miles, the low-water fall is about 5 feet. The river for a short distance below the railroad bridge is, at low water, about 200 feet wide and from 1 to 2 feet in depth. Beyond that point, with the exception of Cedar Shoals and a few other points where excessive widths obtain, the river is from 75 to 125 feet in width, with low-water depths not exceeding in places 1 foot.

At Cedar Shoals the river falls 41.2 feet in about one-third of a mile. Just below, at Henry Shoals, there is a fall of 18.8 feet in about a quarter of a mile, or a total fall of 60 feet in less than a mile. Below these there are other shoals with falls varying from a few inches to 11.5 feet.

There is then a total fall of 93 feet over the shoals between the Georgia

Digitized by Google

Railroad Bridge and the mouth of Yellow River, making, with the river slope at other points, a total fall of about 110 feet in 21.5 miles, or an average of more than 5 feet per mile.

The low-water discharge of the river is about 400 cubic feet per second, with velocities in the pools of from 1 to 2 miles per hour.

Freshets are of frequent occurrence, and attain heights of from 3 to 20 feet above summer low water, ordinary high water being from 2 to 6 feet above that level.

The river is crossed between the railroad and its mouth by four bridges, which are described in Lieutenant Rees's report.

To obtain a steamboat channel 5 feet deep at summer low water will require the improvement of the river by locks and dams and the construction of a canal around Cedar Shoals. There will be required a total lift of about 115 feet, which will cost, approximately, $1,500,000. This improvement completed would give an isolated portion of about 20 miles of river closed to navigation both above and below.

The only communication received by me evincing any desire for the improvement of the river relates to that portion between the railroad bridge and Cedar Shoals. The stream is nowhere between those points more than 3 miles distant from the railroad.

There is at present no commerce whatever upon the river, and it is not probable that the proposed improvement would develop any commerce commensurate with the outlay required, if indeed it would develop any commerce at all.

For all of the reasons given, I am of the opinion that the "Yellow River, Georgia, from the railroad bridge near Covington to the Ocmulgee, with a view of obtaining a steamboat channel of 5 feet deep at mean low water" is not worthy of improvement.

APPENDICES.

1. Report of Lieut. Thomas N. Rees, Corps of Engineers, U. S. A.
2. Petition of the Central Ocmulgee Navigation Company.

MAPS.

1. Index map of Yellow River, Georgia, scale 1:30,000.
2. Detail map of Yellow River, Georgia (4 sheets), scale 1:6,000.
3. Map accompanying petition of Central Ocmulgee Navigation Company.

Very respectfully, your obedient servant,

O. M. CARTER,
Capt., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., March 14, 1891.

Respectfully submitted to the Chief of Engineers.

Because of the facts and reasons stated by the local engineer, it is my opinion that the improvement of the Yellow River from the railroad bridge near Covington to the Ocmulgee, with a view of obtaining a steamboat channel 5 feet deep at mean low water, is not worthy to be undertaken by the United States.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Digitized by Google

REPORT OF LIEUTENANT THOMAS H. REES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Savannah, Ga., February 20, 1891.

SIR: I have the honor to submit the following report of an examination of the Yellow River, Ga., from the railroad bridge near Covington to the Ocmulgee, with a view of obtaining a steamboat channel 5 feet deep at mean low water.

The examination was made pursuant to your letter dated October 11, 1890, requiring "the ascertainment of the general direction and widths of the river, the lengths and depths of the pools and shoals, the fall over the shoals, the height of banks, the size and character of the trees and brush bordering the river, and the location and character of the bridges. Also, the amount of the present commerce on the river, if any, and the commerce which might be developed by its improvement."

I proceeded to Covington, Ga., on November 28, 1890, and having secured a boat and a crew of 2 men, began work the next morning. The courses were run by a box compass. Distances were estimated. Soundings were taken while the boat moved from one station to the next. The river was at a very low stage, and therefore favorable for the purposes of the examination.

The Yellow River rises in the northern part of the State of Georgia and flowing about south-southeast joins the South River about 15 miles south of Covington, forming with it the Ocmulgee River. The distance by the river from the Georgia Railroad Bridge to the Ocmulgee is 21¼ miles. Just below the bridge, and for a distance of about one-half of a mile, the river is from 1 to 2 feet in depth, excessive in width (about 200 feet), spreading out over a sandy bottom. Below this point it narrows to about 75 feet, but the depths remain the same and the current increases slightly, to a rate of about 2 miles per hour. At the Horse Shoe, 1½ miles below the bridge, the river makes a bend of more than 180 degrees, with a radius of about 125 feet, and has a width of from 50 to 70 feet. The bend is further obstructed by rocks. At the 2-mile point the current slackens to about one-half mile per hour, beginning to feel the effects of the backwater from the milldam at Cedar Shoals (5¾ miles). From this point to the shoals the width and depth of the river gradually increase, the width running from 100 to 150 feet, and the depth from 4 to 10 feet.

The village of Porterdale (5¾ miles) occupies the hill on the west bank of the river at the head of Cedar Shoals and is an adjunct to the cotton mills established there to utilize the excellent water power available.

A dam from 4 to 6 feet high is built on the crest of the shoal. The fall from the level of the mill pool to the pool below the shoals is 41.2 feet in a distance of about one-third of a mile. The water flows in many divided streams, and with many leaps and rapids, down a steep, rocky slope and has hardly recovered its tranquillity at the foot before it is hurried in the same manner over the Henry Shoals, falling 18.8 feet in about a quarter of a mile. There is, therefore, at this point, a total fall of 61 feet in less than a mile. Within the next half of a mile are three small shoals, the first having a fall of 6 inches in 50 feet, the next a fall of 9 inches in 40 feet, and Hanson Shoals (7 miles) with a fall of 2 feet in 400 feet. The next 2 miles of the river has a uniform width of about 100 feet and a depth of from 1½ to 2 feet, but is badly obstructed by projecting rocks. At Langston Shoals (9 miles) the river receives a tributary known as Dried Indian Creek. The shoals are about 800 feet long and have a fall of 5.5 feet. The next pool is about 3 miles long, from 70 to 120 feet wide, and with depths varying from 1.5 to 3.5 feet. The velocity of flow is about 2 miles per hour. Flat Shoals (12 miles) have a fall of 4 feet in a length of about 1,000 feet. Then comes a straight reach in a length of about a mile, with widths of from 80 to 140 feet and depths of from 2 to 3 feet, followed by the Fish Dam Shoals (13 miles) with a fall of about 1 foot. The next pool is 3 miles long and has a uniform width of about 100 feet and depth varying from 2 to 5 feet. Under and below Webb's Bridge (16 miles) are Webb's Shoals, having a fall of 2 feet in a length of about 400 feet. For the next mile and a half the river is of the same description as it is above the shoals, rock, sand, and gravel alternating in the river bed, and frequent rock ledges obstructing the channel. Lee Shoals, at 17¾ miles, have a length of about 600 feet and a fall of 3.7 feet. At 18 miles there is another sharp fall of 2 or 3 inches. Then comes in order, with the same characteristics as above, a pool three-fourths of a mile long; Allen Shoals (18¾ miles), with a fall of 2 feet in 150 feet; a pool 2 miles long and from 3 to 7 feet in depth; then the Indian Fishery Shoals (20¾ miles), falling 11.5 feet in about 500 feet. A number of islands at the foot of these shoals divides the river into several channels. The next pool is about half a mile long, and at its lower end the Yellow River joins the South River to form the Ocmulgee.

The examination was continued to the mouth of the Alcovey River in order to reach a point where transportation back to Covington could be obtained.

The two rivers came together at the head of Barnes Shoals (21½ miles), where there is a fall of 11.5 feet in a length of about 1,000 feet. Below these shoals the

Digitized by Google

Ocmulgee River is about 200 feet wide and varies in depth from 3 to 10 feet. A small shoal, with a fall of about 3 inches, occurs at the 22-mile point, and another, with 2 inches fall, at the 22½-mile point. Lemon's Shoals, at 23 miles, has a fall of 2.3 feet in a length of about 150 feet. A quarter of a mile below these shoals is the mouth of the Alcovey River, where the examination ended.

The above description of the river applies, of course, only during a low-water stage. The river is subject to great fluctuations in level, the ordinary high-water mark varying in different places between 2 and 6 feet above low water, and the freshet height between 13 and 20 feet, except on and just above the shoals, where the fluctuations are small, not exceeding from 3 to 5 feet, even during freshets. There would probably be no evidence of the smaller shoals during high water.

BRIDGES.

The Georgia Railroad Bridge, crossing the river about 4½ miles northwest from Covington, is a Howe truss deck bridge, about 350 feet long, in three spans, 100 feet, 150 feet, and 100 feet, respectively. The two piers are of stone, about 30 feet high, and the lower chord is about 32 feet above low-water level.

Wood's Bridge, just below the railroad bridge, is a low, wooden, trestle bridge about 150 feet long, and is only 3 feet in the clear above low water. The decking is sloping, the upstream side being about 5 inches lower than the downstream side. It was found that high bridges were invariably carried away during freshets, and low sloping bridges are now usually built on the river, so that when the water rises high enough to bring down logs, driftwood, etc., the bridges will be entirely covered and floating objects will pass over them without doing any damage.

Brown's Bridge (3 miles) is a wooden trestle-bridge about 140 feet long and 18 feet in the clear above low-water level. The freshet height is about 3 feet above the top of this bridge.

Webb's Bridge (16 miles), and Lee's Bridge (20 miles), are low wooden bridges similar in all respects to Wood's Bridge.

THE RIVER VALLEY.

The river flows through the red clay hills of north central Georgia, an excellent farming country, well settled and thoroughly cultivated. None of the original forests remain. Second growths of pine, oak, gum, etc., are the only timber and are too small to be of any value for lumber.

The river valley from the railroad bridge to Cedar Shoals is said to contain numerous deposits of excellent molding and building sand, terra cotta clay, and of red ochre, which would probably be of considerable value if the river were put in condition for navigation, so that they could be conveyed to market.

The manufacture of brick was begun at Carroll's Boat Landing for furnishing material for the construction of the mills at Cedar Shoals, the brick being carried there by flats used as pole-boats. This industry ceased, however, with the completion of the mills.

There is no commerce on the river, nor is river traffic possible under existing conditions. With the exception of the development of the mineral deposits along the portion between the railroad bridge and Cedar Shoals there is no industry or trade that I could hear of that would be benefited by the opening up of the river to navigation. Even if opened to the Ocmulgee, traffic could go no further, being stopped at the outset at Barnes Shoals, with a fall of 11.5 feet; and there are numerous shoals even more difficult to overcome on the Ocmulgee River before navigable waters are reached.

With respect to the portion above Cedar Shoals, the river here is at no point more than 3 miles from the railroad and the average distance is less than 2 miles. Therefore, if there are mineral deposits along this portion of the river awaiting development, it is difficult to believe that the opening up of the river would have any beneficial effect in expediting that development. An industry of any considerable value is not checked by the difficulties of a 2 or 3 mile haul. Moreover, this portion of the river is already in as good condition as the volume of water will maintain. The low-water discharge is not greater than 400 cubic feet per second, and in order to obtain a navigable channel 5 feet in depth it would be necessary to resort to slack-water navigation, which might be obtained by raising the Cedar Shoals Dam 4 or 5 feet at a cost of about $10,000.

The improvement of the river below Cedar Shoals would require the construction of an expensive system of locks and dams. The total fall to be overcome is about 90 feet at the shoals and rapids alone, not including the fall due to the slope of the pools. The improvement of this river would be of little worth without a similar improvement of the upper waters of the Ocmulgee as far as Macon. Here are also many shoals of like character to those of the Yellow River and with a much greater fall to overcome.

Digitized by Google

In short, the improvement of the Yellow River and the attainment of a navigable channel 5 feet in depth between the Georgia Railroad Bridge and the Ocmulgee would probably cost not less than $500,000. If there be any prospective benefits arising from such improvements commensurate with that outlay I have been unable to discover them.

MAPS.

The notes of the examination have been platted to a scale of 1: 6,000, and the resulting maps in three sheets accompany this report.

Very respectfully, your obedient servant,

THOS. H. REES,
First Lieutenant, Corps of Engineers.

Lieut. O. M. CARTER,
Corps of Engineers, U. S. A.

LETTER OF CENTRAL OCMULGEE NAVIGATION COMPANY.

COVINGTON, GA., *December 4, 1889.*

GENTLEMEN: In behalf of the Central Ocmulgee Navigation Company, of Newton County, Ga., and of the citizens also, I present the inclosed and accompanying documents and respectfully ask your approval of the same. If approved by your honorable body please sign and send them to the Speaker of the House of Representatives in Congress, in the care of the Hon. John D. Stewart, member of the House of Representatives in Congress from the Fifth district of Georgia.

Respectfully submitted.

HARRY CAMP,
Secretary and General Manager of the Central Ocmulgee Navigation Company.

The honorable BOARD OF ENGINEERS FOR RIVERS AND HARBORS FOR THE STATE OF GEORGIA.

PETITION OF CENTRAL OCMULGEE NAVIGATION COMPANY.

OFFICE OF THE CENTRAL OCMULGEE NAVIGATION COMPANY,
Covington, Ga., February 15, 1889.

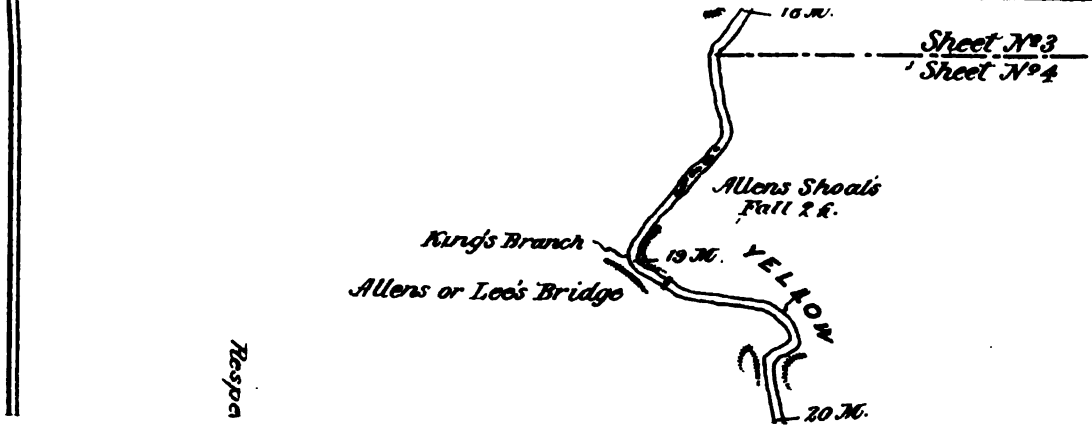
The petitioners whose names appear, respectfully show to your honorable body that in the year 1875 the United States Government caused a survey and soundings to be made along the Ocmulgee and Yellow rivers from the Georgia Railroad Bridge in Newton County to the city of Macon in Bibb County, Ga., a report of which was made by Bushrod W. Froebel (then acting United States engineer) to the Congress next in session after said survey and soundings were made. Your petitioners further show that the part of said survey and soundings between the Georgia Railroad Bridge and Cedar Shoals, in Newton County, Ga, is bordered on each side of said stream by large beds of granite, molders' sand, terra-cotta clay, and mineral paint (all heavy substances) lying dormant for want of cheap transportation. Your petitioners further show that all that part along said stream between said points is subject to overflow and can not be relied upon for agricultural purposes alone. Your petitioners further show that the land owners along said stream are not able to put said stream in condition for a small steamer to run safely without the aid of Government, and that an appropriation by the General Government of $10,000 would be sufficient to put said stream in good order for small steamers and thereby establish four large industries and add greatly to the value of property along said stream. We herewith present for the consideration of your honorable body a map showing the geological features of the soil on both side of said stream, carefully made by James M. Gieger, county surveyor of Newton County, Ga.

Respectfully submitted.

W. SCOTT,
President.
DAVID H. HOBERT,
Treasurer.
HARRY CAMP,
Secretary and General Manager.

To the SPEAKER OF THE HOUSE OF REPRESENTATIVES,
UNITED STATES CONGRESS.

Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

APPENDIX O.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN FLORIDA.

REPORT OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. St. Johns River, Florida.
2. Ocklawaha River, Florida.
3. Volusia Bar, Florida.
4. St. Augustine Harbor, Florida.
5. Northwest entrance, Key West Harbor, Florida.
6. Caloosahatchee River, Florida.
7. Channel of Charlotte Harbor and Pease Creek, Florida.
8. Sarasota Bay, Florida.
9. Manatee River, Florida.
10. Tampa Bay, Florida.
11. Withlacoochee River, Florida.
12. Harbor at Cedar Keys, Florida.
13. Suwanee River, Florida.

EXAMINATIONS.

14. St. Johns River, Florida, from Jacksonville to Sanford; and the upper part of St. Johns River, from Lake Monroe southward.
15. St. Augustine, Florida, for improvement of channel so as to make a deep sea channel over the outer and inner bars.
16. Indian River, Florida, between Titusville and Jupiter Inlet.
17. Channel lying north and west of the town of Cedar Keys, Florida, known as Boat or Number Four Channel.
18. Peace [Pease] River, Florida.
19. Charlotte Harbor, Florida.

HARBOR LINES.

20. Establishment of harbor lines in St. Augustine Harbor, Florida.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., July 10, 1891.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Digitized by Google

O 1.

IMPROVEMENT OF ST. JOHNS RIVER, FLORIDA.

The portion of the river under improvement from Jacksonville to the ocean may be divided into four reaches, as follows:

1. Jacksonville to Dame Point: Length, 12.4 miles; average channel width between 20-foot contours, 1,100 feet; between 15-foot contours, 1,300 feet; minimum 15-foot channel width, 550 feet; minimum mid-channel depth, 20 feet; mean range of tide, 1.2 feet.

2. Dame Point to Beacon No. 1 (1 mile below St. Johns Bluff): Length, 7.5 miles; aggregate length of channels less than 15 feet deep, 1.3 miles; average width of these channels between 9-foot contours, 850 feet; minimum width between 9-foot contours, 400 feet; minimum midchannel depth of defective portions, 12.5 feet; minimum midchannel depth o remainder of reach, 15 feet; range of tide, 2.15 feet.

3. Beacon No. 1 to mouth: Length, 5 miles; average width betwee 20-foot contours, 700 feet; between 15-foot contours, 870 feet; minimu mid-channel depth (except at one place 1 mile long) 20 feet; depth a excepted place, 15 feet; range of tide, 3.41 feet.

4. Mouth to outer bar: Distance, 2.5 miles. Before the improvemer was begun this was crossed by shifting channels from 2.1 to 2.5 mil long and having a mean low-water depth of from 5 to 7 feet. The tid range on the outer bar is 5.8 feet. There are two channels across t bar. The north channel crosses the line of the prolongation of t north jetty axis at a slight angle. It has a least mean low-water dep of 10.5 feet, found on the crest of the bar. The south channel, th used by vessels, crosses the line of Ward Bank and the prolongati of the south jetty axis, passing close to the end of the jetty. It has least mean low-water depth on the bank between the jetties of 11.5 f and on the outer bar of 13 feet.

PROJECT OF IMPROVEMENT.

The operations for improving this channel have been carried on accordance with a project submitted to the Chief of Engineers, Ju 30, 1879, by the late Gen. Q. A. Gillmore, colonel, Corps of Engine and printed as part of Appendix I 7, Annual Report of the Chief Engineers for 1879.

The approved project is to obtain a least mid-channel depth of 15 f at mean low water from Jacksonville to the ocean. This depth is to obtained across the bar at the mouth by concentrating and direct the flow of the river by two long jetties, starting from opposite sides the entrance and converging until, near their outer extremities on bar, they shall be 1,600 feet apart. The jetties are to be built of rip stone on mattresses of log or brush and suitably capped. Accord to a detailed project approved June 11, 1891, the ship channel in defective reach, Dame Point to Beacon No. 1, is to be deepened dredging and protected by dikes and shore revetment of cheap construction. The estimated cost of this portion of the work is $205, and of the entire improvement $1,622,000. General Gillmore's orig estimate was $1,426,000. The increase in cost is due mainly to the crease in the depth of water in which the jetties must be built, cau by the scour around the ends during the long period of time in wh the work has been carried on, and to other effects of the intermitt prosecution of the work.

Digitized by Google

OPERATIONS PRIOR TO JUNE, 1890.

Operations were carried on under six appropriations made in 1880, 1881, 1882, 1884, 1886, and 1888, aggregating $850,000. Of these the first five were for improving the channel over the bar at the mouth only. The last was made available for the complete project. The work was done almost entirely by contract, as funds were available. On June 30, 1890, the progress of the jetty construction was as follows:

South jetty.—Total length, including shore extension, 7,147 feet; length at full height and capped, 1,740 feet; additional length built to mean low-water level, but with insufficient width of crest, 2,740 feet; length with crest averaging 1 foot below mean low water, 800 feet; average mean low-water depth over the remaining length, 5 feet; total amounts of materials of construction used, log and brush mattresses, 203,063.6 square yards; riprap stone, 77,849.6 cubic yards; oyster shells, 2,880.83 cubic yards; concrete, 218 cubic yards.

North jetty.—Total length, including shore extension, 9,048 feet length at full height and capped, 553 feet; length with crest (of insufficient width) at level of mean low water, 6,404 feet; mean low-water depth over remainder 1 to 5 feet; materials of construction used, log and brush mattresses, 62,581 square yards; brush mattresses, 35,000 square yards; riprap stone, 72,073.9 cubic yards; oyster shells, 5,325.41 cubic yards; concrete, 337.8 cubic yards.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1891.

Operations during the summer, with the retained balance of the appropriation of 1888, comprised the care of the property, the construction of a greatly needed storehouse and wharf, the construction of wings to the shore extension of the south jetty, and some slight general repairs to the jetties.

An appropriation of $170,000 was made in the act approved September 19, 1890, for continuing the improvement "from Jacksonville to the ocean." On October 18 the United States suction dredge *Woodbury* was brought to St. Johns River for experimental work in the north channel between the jetties. The boat remained in the St. Johns until December 12, dredging in the Dame Point Reach when rough weather prevented work in the bar channel. One thousand eight hundred and eighty-seven and five-tenths cubic yards of sand were dredged at the bar and 2,352 cubic yards in the Dame Point Reach. No permanent deepening was made at either place. After due advertisement proposals were opened November 15, 1890, for continuing the jetty work. A contract for the work was entered into with Mr. Marcus Conant, of Mayport, Fla., the lowest bidder, which was approved by the Chief of Engineers December 24. The first stone was deposited on the jetty under this contract February 6, 1891. Up to June 30 3,731.2 cubic yards of stone had been placed in the south jetty, extending its superstructure in a narrow ridge, with the crest at the general level of mean low water, from Station 4915 to Station 5940; 14,783 square yards of brush mattresses had been placed in the foundation of the north jetty, extending it from Station 8991 to Station 10108, and ballasted with 6,905.7 cubic yards of stone. Nine hundred and fifty-one and four-tenths cubic yards of stone had been placed in the north jetty superstructure, between Station 6470 and Station 7010, strengthening and widening the crest and building it to a level 2 feet above mean low-water.

Digitized by Google

On June 8, in response to a circular letter, sealed proposals were received and opened for furnishing and placing on the crest of the jetty heavy rock in blocks varying in weight from 1 to 6 tons, and of which 50 per cent. must be in blocks weighing 4 tons and over.

By authority from the Chief of Engineers a contract for this stone is being entered into with Mr. John Satterlee, of New York, N. Y., the lowest bidder. Other work during the fiscal year comprised partial surveys of the bar made from time to time and the annual survey of the bar and vicinity. This last was made by a party in charge of Mr. J. H. Bacon, assistant engineer, whose report is appended.

MATERIALS AND METHODS.

The methods of construction employed are all generally as explained in former reports. In floating the brush mattresses to position for sinking, the contractor has found it advantageous to suspend the mattress by lines from four small scows placed at intervals over it, as well as from the large stone flats at the ends. The mattress used is of brush, as described in the Annual Report for 1889, modified by leaving out a portion of the poles of the top grillage. No oyster shells have been used as yet in this contract, though their use as hearting will be continued. The stone used was obtained from Florida, New York, and Connecticut and weighed loosely piled 1 ton, 1.21 tons, and 1.35 tons per cubic yard respectively (tons of 2,000 pounds). The rapidity of the growth of shell-fish, barnacles, and oysters on all of this stone as well as on the concrete in the jetties is quite remarkable.

The concrete coping placed in the north jetty in 1887 is entirely covered with sand. When examined it was found to be very hard and in excellent condition. That placed during the last fiscal year has stood well and is now covered with barnacles nearly to the level of high water. None of the light concrete coping of the shore end of the south jetty was displaced by the waves. At two places it was lowered by the light shell and riprap below being knocked out after the riprap side slopes had been carried away. Some of this concrete is very poor in cement and is as soft as the softest sandstone, but there has been no observed wear since the boxing was removed.

The sand movement on the beach on the south side of the river is from outside the jetty in, as was observed on the north shore. To facilitate this movement a portion of the coping of the jetty was removed just at the high-water mark, leaving a gap about 15 feet long. At each tide large quantities of sand pass through this from outside in. This movement is by wave and current action combined.

TIDES AND TIDAL CURRENTS.

Tidal range was observed at Mayport, near the shore end of the south jetty, both inside and outside the jetty, and near the sea end of the south jetty. The observed ranges were, at Mayport, 4.6 feet; inside shore end of south jetty, 5.1 feet; outside shore end of south jetty, 5.4 feet; at sea end of jetty, 5.8 feet, corresponding to the ranges previously observed. The abnormal condition of weather prevailing made it impossible to determine whether the low-water plane at Mayport had been changed by the jetties.

Observations for tidal currents off the coast were made on June 5 from 7 a. m. to 5 p. m. The stations were on the 30-foot contour, and situated, No. 1, off Little Talbot Island, 5½ miles north of the St. John's

Digitized by Google

Bar Buoy, and No. 2 off St. Johns Bar, and No. 3 off Pablo Beach, 6¾ miles south of the bar. The observations were made with loaded rods 19 feet long. The positions of the stations and the directions and velocities of the currents are shown on plate No. 4. An analysis of the observations is given in Mr. Bacon's report, appended.

From these and previous observations, Mr. Bacon makes the following deductions, which seem well founded for this vicinity.

(1) The littoral currents, away from the influence of tidal streams and estuaries, are governed directly by the force and direction of the wind. The rise and fall of the tide seems to have little or no influence.

(2) At a point immediately outside of St. John Bar the ebb tide of the river has an influence on the current, but the flood tide in the river appears to be independent of the littoral current outside, which at the 30-foot contour has no tendency to enter the river, except under the influence of an easterly wind.

(3) The range of the tide outside of St. John Bar, and probably on the shores above and below the jetties, is about 1.2 feet greater than at the mouth of the river.

PRESENT CONDITION OF JETTIES.

South jetty.—The total length of this jetty is 7,147 feet, of which 1,740 feet from Station —480 to Station 1260 is built to the full height; thence to Station 5940, a distance of 4,680 feet, the crest of the jetty is above mean low water, except for a few small gaps at the outer end, where the depth is from 2 to 3 feet at mean low water. From Station 5940 to Station 6667, a distance of 727 feet, the crest of the jetty slopes from mean low water to a depth of 13 feet. (See Plate No. 2.)

The condition of the jetty remains stable. There has been a slight lowering of the crest in spots, which was doubtless caused by the action of the sea against the riprap forming the crest, causing it to assume a more stable slope. There is no indication of any subsidence caused by underscour.

Up to date, 203,063.6 square yards of mattress, 81,580.8 cubic yards of riprap, 2,880.83 cubic yards of shell, and 218 cubic yards of concrete have been used in the construction of this jetty.

North jetty.—The total length of this jetty including the shore extension is 10,165 feet. Five hundred and fifty-three feet of this (from Station —57 to Station 496) the jetty is built to the full height and capped. For 6,514 feet (to Station 7010), the crest is above the level of mean low water with the exception of a few places where the depth varies from 1 to 2 feet. From Station 7010 to the end of the jetty, a distance of 3,098 feet, the average depth over the jetty at mean low water is 5 feet. The average width of the crest out to Station 7010 is about 12 feet. (See Plate No. 4).

No evidence of settlement due to underscour is shown on any portion of the jetty. The lowering of the crest above mentioned is due to the action of the breakers.

The crest of the exposed portions of this jetty can be held above the level of mean low water only by means of heavy capping. That portion capped with concrete in 1888 is completely covered with sand.

Up to date, 112,364 square yards of mattress, 79,931 cubic yards of riprap, 5,325.41 cubic yards of shell, and 337.8 cubic yards of concrete had been used in the construction of this jetty.

The riprap on the older portions of each jetty has been closely cemented together by shellfish.

CHANGES SHOWN BY SURVEY OF 1891.

The shore lines in the vicinity of both jetties are practically in the same position as last year. The shore extension of the south jetty from Station 1 to Station 2 has settled about 2 feet. This was caused

Digitized by Google

by the high storm tides during the month of April, which scoured a slough accross the jetty at this point. The riprap forming this portion of the shore extension was placed on the sand which accumulated over the original mattress, and consequently no opposition to scour was offered. This slough, however, is dry except at high water, and shows signs of filling. With this exception the shore extensions of both jetties are practically in the condition reported in 1890.

There has been but little change in the areas outside the jetties. Comparison with the map of 1890 shows a slight shoaling north of the north jetty, and slight increase of depth along seaward side of the outer end of the south jetty. The shoal bare at low water, directly south of the south jetty (formerly known as Pelican Bank), is nearly three times as large as in 1890.

The depth in the channels between the jetties, especially in the north channel, has been steadily increasing. The inner 12-foot contour of the north channel has moved seaward 2,100 feet; the outer 12-foot and 18-foot contours have moved seaward about 800 feet. There has been practically no movement of the outer 24 and 30 foot contours. The available depth at mean low water through the north channel is now 10 feet, where in 1890 it was only 4.5 feet. The distance between the inner and outer 12-foot contours is now 700 feet. In 1890 this distance was 2,600 feet. The south channel is still used by all deep-draft vessels. The available mean low-water depths across the bar and the middle ground separating this channel from the north channel are 13 and 11.5 feet, respectively, against 11.2 and 8.9 feet of last year. The present channel crosses the middle ground at a point about 3,600 feet east of the channel formerly used.

All traces of Ward Bank have disappeared. The area included in the 6-foot contour formerly surrounding this bank has been diminished by nearly one-half during the year; in fact the only portion left is that lying between the outer ends of the jetties.

The movement of sand during the year has presented no unusual features, and the work accomplished has been in the anticipated direction. The long suspension of work from October, 1889, when the contract work under the appropriation of 1888 was finished, to February, 1891, when contract work under the appropriation of 1890 was started, increased the cost of the improvement materially by increasing the depth in which the north jetty must be prolonged from 5 to 6 feet in 1889 to 13 to 16 feet in 1891. With a width of 15 feet at mean low water and side slopes of 1 on 2, the increase in area of jetty cross section from the area required for a depth of 8 feet to that required for a depth of 16 feet is 440 square feet. At the present contract rates this means an increase of cost of $33 per running foot of jetty. Considering this fact and the increased length of jetty required by the growth of the bar seaward in the long period since the work was begun (1882), the increase of the estimated cost of the improvement from $1,426,000 to $1,622,000 is readily understood.

As stated in the last annual report, the completion of this improvement is of vital importance to the city of Jacksonville, and is important in a less degree only to the State and country. The volume of commerce which will be affected by it must not be measured by the tonnage at present using the river. With the slight depth available, only a special class of vessels, those of light draft, can enter the port. This absolutely prohibits economical trade with foreign countries and limits the traffic to freight for home ports for which a large rate can be paid. As a result, either other products are given a longer haul by rail to other

Digitized by Google

and deeper ports, or, as is frequently the case, the cost of carriage is so increased that production is unprofitable and the land is undeveloped. Almost all of the large and rapidly increasing shipments of phosphate from the State which now seek Atlantic ports are now carried by rail directly past the St. Johns River:

The personnel of the work is the same as during the last contract. I wish to express my indebtedness to them again for the aid they have given in the conduct of the work.

The improvement is located in the collection district of St. John. Jacksonville is the nearest port of entry. Nearest light-house is St. Johns River light. Nearest fort is Fort Clinch, Fernandina, Fla.

The following papers accompany this report, viz:

Report of Mr. J. H. Bacon, assistant engineer.
Plate No. 1. Map of Bar and Vicinity.
Plate No. 2. Plans and Profiles of Jetties.
Plate No. 3. Comparative maps of Bars.
Plate No. 4. Diagram of Current Observations.

Money statement.

July 1, 1890, balance unexpended		$23,094.51
Amount appropriated by act approved September 19, 1890		170,000.00
		193,094.51
June 30, 1891, amount expended during fiscal year		38,241.50
July 1, 1891, balance unexpended		154,853.01
July 1, 1891, outstanding liabilities	$18,213.57	
July 1, 1891, amount covered by uncompleted contracts	106,979.91	
		125,193.48
July 1, 1891, balance available		29,659.53
Amount (estimated) required for completion of existing project		602,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		500,000.00

Abstract of proposals for improving St. Johns River, Florida, received in response to advertisement and opened November 15, 1890, by Captain W. M. Black, Corps of Engineers.

No.	Name of bidder.	Stone (per ton of 2,000 pounds).			Oyster shells (per cubic yard).			Mattresses (per square yard).	
		In the jetty outside the shore mean low-water line.	In the jetty inside the shore mean low-water line.	On shore between mean high and low-water lines.	In the jetty outside the shore mean low-water line.	In the jetty inside the shore mean low-water line.	On shore between mean high and low-water lines.	In the work.	Total.
1	J. E. Slaughter	$2.24 9/10	$2.34 9/10	$2.39 9/10	$0.69 9/10	$0.74 9/10	$0.74 9/10	$0.75	$133,949
2	J. A. Bryan	2.23	2.40	2.70	1.00	1.25	1.50	.70	132,780
3	E. H. Gaynor	2.77	2.90	3.00	1.35	1.50	1.60	.69	159,010
4	Marcus Conant	2.07	2.32	2.57	1.20	1.40	1.40	.70	126,420
5	Joseph Evins	2.69	2.74	2.84	.95	1.05	1.15	.70	153,690
6	R. G. Ross	2.25	2.45	2.45	1.25	1.25	1.25	.60	131,350

NOTE.—As given in paragraph 1 of the specifications, the estimated quantities of materials required are as follows: Stone, 46,000 tons (of 2,000 pounds); oyster shells, 5,000 cubic yards; mattresses, 3,600 square yards.

[1] Lowest bid.

[2] This bid (No. 6) was accompanied by a proposal to furnish stone of a quality poorer than that called for at $2 per ton of 2,000 pounds.

Digitized by Google

The estimated amount available for work according to the approved project $130,000.

Recommended that bid No. 4 be accepted.

Abstract of proposals for furnishing stone for use in improving St. Johns River, Flori received in response to circular letter and opened June 8, 1891, by Capt. W. M. Bla Corps of Engineers.

No.	Name and address of bidder.	Price ton (2, pound
1	Marcus Conant, Mayport, Fla	$
2	John Satterlee, New York, N. Y.	

Amount available, $5,000

Recommended that the bid of Mr. John Satterlee be accepted.

REPORT OF MR. J. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., June 30, 189.

CAPTAIN: I have the honor to submit the following report on the survey of Johns Bar, Florida. The survey was begun on May 13, and finished on June 6.

Soundings were taken over the area usually covered and were located by mean a transit and sextant. Soundings on the bar were made with a pole; all others w a lead-line.

The usual cross-sections of the jetties were made, and the high and low wa shore lines were located.

A tide gauge was established at a point near the outer end of the south jetty, fi which the bar soundings were reduced. Observations of that gauge, in connect with those taken at the inner end of the jetty and at Mayport, furnish the follow data:

Mean range of tide at St. Johns entrance.

	Fe
On the bar	5
At the inner end of south jetty (outside)	5
At the inner end of south jetty (inside)	5
At Mayport, Fla	4

No definite conclusions as to any change of range of tide, due to the influenc the jetties, can be obtained, owing to the strong easterly winds which prevailed d ing the survey, and which kept the water abnormally high.

An examination of the concrete blocks on both jetties was made.

South jetty.—The edges and corners of many of the blocks are rounded off. M of this erosion probably occurred immediately after the blocks were placed in p tion, before the cement had set. Where the high water swashes over the shore tension, there has been considerable settlement. There has also been considerable tlement at the outer end of the work, where the partition blocks have been remov

As a rule, the blocks are in fairly good condition, and of about the consistency building sandstone. There seems to be no difference between the blocks compc of shell, sand, and cement and those of sand and cement. There is a slight dif ence in hardness between the Portland and Rosendale in favor of the former.

North jetty.—The concrete blocks placed at Station 1 are all in position, exc the lower tier on the outside, which have dropped down owing to the sharp slop the riprap beneath. One block on the inside is turned on edge. The blocks ar good condition.

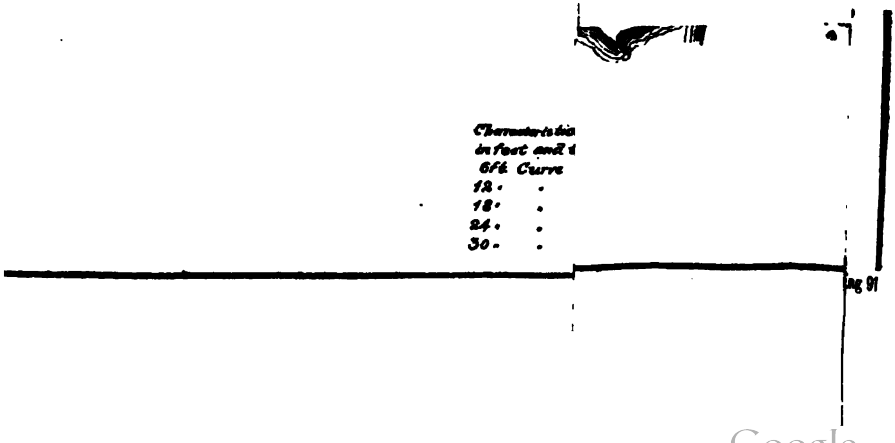
The shore extension of the north jetty is entirely covered with sand. Three blo were examined at different points, and all were found to be extremely hard, of ab the consistency of brick. All of these blocks were of Portland cement.

CURRENT OBSERVATIONS.

Observations for direction and velocity of current were made at three stations the 30-foot contour: Station No. 1, opposite the entrance to Nassau Sound, Station 2, on St. Johns Bar, and Station No. 3, opposite Pablo Beach. These observati were made with loaded rods 20 feet long, submerged about 19 feet.

Digitized by Google

Digitized by Google

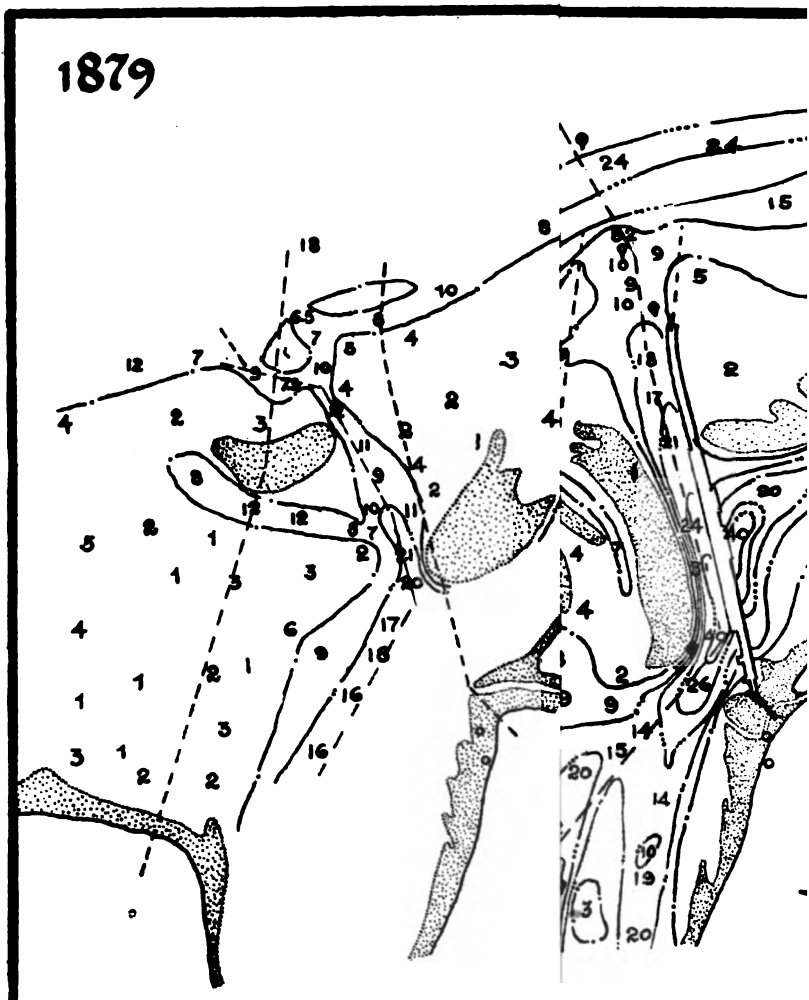


Digitized by Google

Digitized by Google

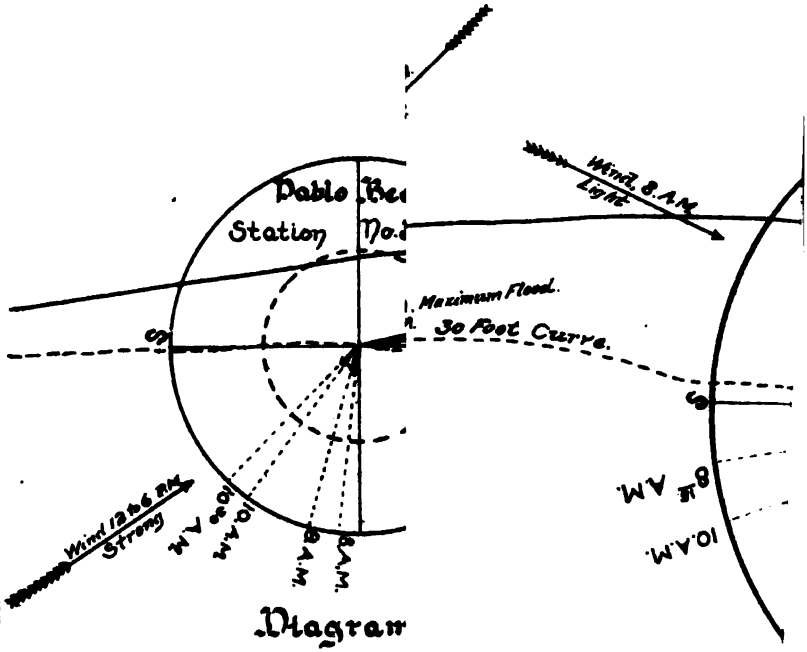
Digitized by Google

Digitized by Google


1879
L.W.
L.W.
Available mean low water depth on the Bar 7.5 Ft.
" " " " " - Middle ground 15.0 Ft.
on the Bar 8.2 Ft.
- Middle ground 14.0 -
1872. 6 Ft Curve is shown thus
12 " " " "
18 " " " "
24 " " " "
30 " " " "
The sailing Line " "
Compas

Digitized by Google

Digitized by Google



Station No.

Diagram

Showing Direction and Velocity

in the vicinity

Saint John's Ba

Statute Miles

From Observations taken June 5

Velocity is measured radially in

from center to arrow-head.

Range of tide on St. John's Bar

Digitized by Google

At Station No. 1 and Station No. 2, between 7 o'clock and 11 o'clock in the morning, the wind was light, and varied from SSE. to W. At Station No. 3, during the same period, there was a light wind from the NW. In the afternoon there was a strong wind from the SE. at each of the stations.

At Station No. 1 the direction of the current during the ebb tide was influenced by the ebb from Nassau Sound; the general direction was at right angles to the coast. The maximum ebb velocity was 0.6 feet per second. The general direction of the flood currents was to the north and parallel to the coast. The maximum flood velocity was 2.0 feet per second. At Station No. 2 the direction of the ebb currents was evidently due to the influence of the ebb currents from the St. Johns River; the maximum ebb velocity was 1.1 feet per second. The general direction of the flood currents was northward and parallel to the coast. The maximum flood velocity was 1.9 feet per second.

At Station No. 3 there was almost no current during the ebb, the maximum velocity being only 0.3 foot per second; the general direction of the ebb was SW.

The maximum flood velocity was 1.0 foot per second. The direction was northerly and parallel to the coast. At this station both the direction and velocity of the current appear to have been governed by the direction and velocity of the wind.

The preponderance of flood velocity over ebb velocity was due to the strong SE. wind which prevailed during the entire flood.

The range of the tide during these observations was as follows:

	Feet.
Gauge No. 1 (Mayport)	6.0
Gauge No. 2, at the inner end of south jetty (inside)	6.55
Gauge No. 3, at the inner end of south jetty (outside)	7.20
Gauge No. 4, at the outer end of south jetty	7.3

Comparing the results of these observations with those obtained from previous surveys, the following conclusions may be deduced:

I. The littoral currents, away from the influence of tidal streams and estuaries, are governed directly by the force and direction of the wind. The rise and fall of the tide seem to have little or no influence.

II. At a point immediately outside of St. Johns Bar, the ebb tide of the river has an influence on the current, but the flood tide in the river appears to be independent of the littoral current outside, which at the 30-foot contour has no tendency to enter the river except under the influence of an easterly wind.

III. The range of the tide outside of St. Johns Bar, and probably on the shores above and below the jetties, is about 1.2 feet greater than at the mouth of the river.

Very respectfully, your obedient servant,

J. H. BACON,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commerce of St. Johns River during the year ending December 31, 1890.

Name of article.	Quantity.	Estimated value.	Gross tonnage.
Cotton ..... bales..	5,250	$205,240	1,050
Fertilizers ..... tons..	21,615	573,300	21,615
Fish and oysters ..... barrels..	125	625	18
Fruits ..... boxes..	194,570	393,950	7,785
Grain ..... bushels..	54,120	43,202	1,624
Hides ..... number..	535	4,000	5
Lumber:			
Rough ..... feet..	53,407,562	373,853	534,075
Sawed ..... B. M..	60,782,390	1,073,335	121,565
Merchandise ..... tons..	45,000	3,500,000	45,000
Vegetables ..... boxes..	9,885	19,150	494
Total	.....	6,186,655	733,231

Vessels.	No.	Average tonnage.	Average draft of water.
			Feet.
Steam	153	600	9
Sailing	168	1,300	10
Coasters	60	25	5 to 6
Yachts	35	.....	6

Digitized by Google

Passengers, number, 10,000. Estimated amount received on same, $180,000.
Estimated percentage of total trade of neighborhood carried by water, 25.
Probable increase of trade were the improvement completed, 200 per cent.

With the dock and wharf facilities here and a greater depth of water to the this port would demand the bulk of the phosphate tonnage of the State. Owin this lack of water the commerce of Jacksonville has been considerably hampe and an immense tonnage of solid cargo freights, which would have sought resh ment by rail from there to interior points, has been diverted and the bulk has ha be shipped by rail and at greatly increased rates.

The future commercial standing of this port depends entirely upon the further provement of the river to the sea.

CHAS. R. HIL

O 2.

IMPROVEMENT OF OCKLAWAHA RIVER, FLORIDA.

The Ocklawaha River has its source in Lake Apopka, central Flori flows slightly west of north for about 104 miles, measured along axis of the channel, then almost due east for 21 miles further whe unites with the St. Johns River. The Ocklawaha River is the prir pal outlet of a number of large lakes, whose aggregate area is ab 175 square miles.

The only important tributary of the Ocklawaha River is the Sil Spring Run, which is 6 miles long, and has an average width of ab 50 feet, and a least depth along the axis of the channel of about 9 f Being the outlet of the famous Silver Spring, its volume of discha varies but little.

From Lake Griffin down for a distance of about 28 miles the ri flows through a wide savanna, submerged about 1 foot under wa and covered with a dense growth of saw grass. On this reach river averages from 30 to 40 feet in width, and has a least chan depth of about 5 feet. The current is very sluggish.

The impediments to navigation on this portion of the river are numerous bends, the narrow channel, floating islands, and eel grass

From the savanna to the mouth, a distance of about 58 miles, banks are covered with a dense growth of cypress and other timbe

On this reach the river averages from 60 to 70 feet in width, and least channel depth is 4 feet. The average velocity of the curren considerably greater than on the upper river, being about 1.3 feet second.

The principal obstructions to navigation are snags and overhang trees.

PROJECT OF IMPROVEMENT.

The approved project is to clear the channel between Lake Gri and the mouth by removing the snags and the worst overhanging tr and by moving the floating islands out of the channel and staking th in place by piles.

The estimated cost of the work at present recommended is $7,500.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891

By act of Congress approved September 19, 1890, an appropriat of $10,000 was made for "improving Ocklawaha River, Florida, to Le burg, on Lake Griffin."

Digitized by Google

Of this amount $2,000 was spent in making a survey of the entire river between Lake Griffin and the mouth.

The field work of the survey was begun on February 20, 1891, and completed on April 23, 1891. The surveying party was under the charge of Mr. J. H. Bacon, assistant engineer, to whose appended report I have the honor to invite attention for information concerning the details of the work.

The permanent improvement of this river would be of great benefit to the orange and vegetable growers in its vicinity, and would thereby benefit a large section of country. The sum in hand is sufficient to clear the river of its worst obstructions, but an annual outlay, estimated at $1,000, will be required for some years to maintain the clear channel.

The Ocklawaha River is in the collection district of St. Johns. The nearest fort is Fort Marion. The nearest light-house is the St. Augustine Light.

The following papers accompany this report:

Report of J. H. Bacon, assistant engineer.
Map of the river.
Photograph of pontoon and camp outfit.*

Money statement.

Amount appropriated by act approved September 19, 1890	$10,000.00
June 30, 1891, amount expended during fiscal year	2,455.68
July 1, 1891, balance unexpended	7,544.32
July 1, 1891, outstanding liabilities	33.42
July 1, 1891, balance available	7,510.90
Amount (estimated) required for completion of existing project	7,510.90
Amount that can be profitably expended in fiscal year ending June 30, 1893, for maintenance	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. J. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER DEPARTMENT,
St. Augustine, Fla., May 11, 1891.

CAPTAIN: I have the honor to submit the following report on the survey of the Ocklawaha River, Florida.

The instructions received were to make a reconnoissance of the river from Leesburg, on Lake Grffin, to the mouth, with approximate measurements of the slope of the water surface, if the funds should permit.

After ascertaining that it would be impracticable to begin the survey at Leesburg, owing to a jam of floating islands a short distance below, it was decided to organize the party at Palatka, on the St. Johns River, 25 miles below the mouth of the Ocklawaha.

On February 4 camp was established near the Palatka Lumber Company's sawmill on the St. Johns River, and work was begun on the construction of a pontoon to carry the camp outfit.

This pontoon consisted of four boats, each 20 feet long and 5 feet beam, having one side straight and the other side curved. These boats were joined together rigidly in pairs, each pair by a transverse stringer 6 by 8 inches by 20 feet. The pairs were then joined rigidly by 3 longitudinal stringers 4 by 6 inches by 30 feet; 6 additional longitudinal stringers, 2 by 4 inches by 30 feet were also used. This made a framework 30 by 20 feet, which was floored over. Three tents and a galley were then set up on the pontoon.

*Not printed.

Digitized by Google

The camp outfit was transferred to the pontoon on February 14, and on the following day the party started for the Ocklawaha River, using the naphtha launch *Myakka* as a tow-boat. The party consisted of myself, Messrs. George Berry, transitman, and C. M. Brown, rodman, 4 laborers, and a cook.

Actual field work was begun on February 20.

The Ocklawaha River for a distance of 28 miles from Lake Griffin flows through a wild prairie, or marsh, submerged about 1 foot under water and covered with a growth of saw grass. From the prairie to the mouth, a distance of about 58 miles, it flows through a cypress swamp. The river is from 8 to 10 feet deep, as a rule, to within 3 feet of the banks, which are nearly perpendicular, and in the lower river are covered with a dense growth of cypress and other timber, and in the prairie with high grass.

Under these circumstances much difficulty was experienced in devising a method for setting up the transit that would allow rapid work. Finally the following method was adopted and used throughout the survey.

Two ladders, each 10 feet long, with sides 4 inches apart and held together by rungs at intervals of 2 inches, were driven into the river bottom, one on each side of the bow of the launch. A cross piece 2 by 4 inches by 8 feet was then passed through each ladder at the desired height, and the transit placed on this. This method of setting up the transit was found to be satisfactory and quite expeditious, as it enabled the transitman to look in any direction without getting out of the boat and without fear of disturbing the instrument.

The progress of the survey, especially in the lower river, was necessarily slow, as, owing to the numerous bends and dense growth, the average length of sights was 300 feet.

The method of conducting the survey was as follows:

Three boats were used, the launch carrying the draftsman and transitman, and two skiffs, each carrying a rodman. The transit was set up and the course, distance, and level to the back sight and fore sight were read and recorded. The height of the instrument above the water surface and the distance to the opposite bank were also noted at each station. The transit was then taken up and the launch moved up to the next station, where the same operation was repeated. Two rodmen were employed, so that, after the observations had been taken to the back sight, the fore sight was generally ready. A drawing board and a roll of cross-section paper were carried in the launch, and, after the course and distance had been recorded, they were immediately plotted on the cross-section paper, using the ruled lines as meridian lines. In this way a complete map, with the exception of soundings, was made as the work progressed. At the end of each day's work the river was carefully sounded back to camp and all obstructions noted. Every morning, as a rule, the camp was moved up to the station last occupied.

Water gauges were observed daily at Welaka, on the St. Johns River, opposite the mouth of the Ocklawaha; at Orange Bend, on Lake Griffin, and at the camp. A gauge was always set up at the end of the day's work and the water level noted, so that any rise or fall of the water during the time of moving camp might be noted and allowed for. During the entire survey, however, the height of the water surface did not vary more than 0.2 foot. There is a daily rise and fall of the tide at Welaka, with a mean range of 0.4 foot. Tidal action also takes place in the Ocklawaha River for a distance of about 1 mile from the mouth, where the range is about 0.1 foot.

From the record of the gauge observed at Orange Bend during February, March, and April, it appears that the water surface during that time fluctuated only 0.2 foot. The gauge observer, Mr. J. O. Arms, an old resident of that section, says that the water surface during this period was at the mean low-water stage, although he has seen it 5 feet higher and 2 feet lower. I was also informed by experienced pilots on the Ocklawaha River that during the survey the river was at the average low-water stage; that it seldom falls lower, and that the high-water stage is about 4 feet higher. The only evidence contrary to this was obtained at Moss Bluff, where I was informed by an old resident that the river was about 0.5 foot above ordinary low water. It is safe to assume, however, that the river was at the ordinary low-water stage, and, as my own observations show, that it remained at this stage during the progress of the survey, all soundings have been plotted without reduction.

The velocity of the current was measured at various points on the way down stream by means of loaded rods. The rod in each case was allowed to float free for several miles and the time of passing each station noted. It was necessary to use two rods, owing to the tendency to float against the concave bank and to catch on bushes, eelgrass, snags, etc. Whenever this happened the spare rod was placed in the channel at the proper point and the other rod taken into the boat.

After carrying up the line of levels a distance of about 50 miles, it was decided to abandon it, as the money allotted for the survey was running short. A line of levels was run from Lake Griffin to the Florida Southern Railway track in Leesburg, and

Digitized by Google

from the gauge at Welaka to the Jacksonville, Tampa and Key West Railway track in Sisco. From these levels, and from information received from the railway officials, the total fall from Leesburg to the mouth of the Ocklawaha was determined.

Numerous bench marks were established at various points on the river. The survey was connected with township corners as frequently as possible. Comparison with a township map of this section shows that the total southing from Welaka to Lake Griffin, according to the reconnoissance, is correct to within 0.1 mile, and the total westing to within 0.3 mile. This, considering the number of sights taken (798), shows as accurate work as could be expected.

TABLE NO. I.

Total distance by river from Leesburg to St. Johns River	miles..	94.00
Total fall of water surface from Leesburg to St. Johns River	feet..	55.00
Average fall per mile	do...	0.58
Velocity per hour for lower river	miles..	0.90
Velocity per hour for upper river	do...	0.40
Maximum velocity per hour	do...	1.20
Minimum velocity per hour	do...	0.35
Average height of high water above mean stage	feet..	4.00
Height of high water of 1870 above mean stage (at Fort Brooke)	do...	10.00

TABLE NO. II.

Distances on Ocklawaha River.

	Miles.		Miles.
St. Johns River	0.0	Cypress Gates	34.6
Winding Place Creek	1.7	Old River	34.7
Turpentine Creek	2.9	Sunday Bluff	37.7
Boyd Creek	3.8	Star Island	40.1
Bear Creek Point	4.2	Hogan Landing	41.3
Bear Creek Inlet	4.3	Pin Hook	41.6
Davenport	6.5	Palmetto Landing	42.0
The Narrows (east end)	6.6	Hell's Half Acre	42.3
Poor Man's Labor	8.0	Parks Landing	42.5
The Narrows (west end)	9.0	Gores Landing	43.4
Dead River	9.0	Straits of Dardin Kennels (north end)	44.2
East Riverside	10.0	Straits of Dardin Kennels (south end)	44.9
Riverside	10.3	Osceolas Old Field	45.8
Deep Creek	11.9	Meyers Landing	46.0
Jack Gates	13.3	Durisoe Landing	46.2
Dutchman Reach	15.1	Rogers Cut (north end)	47.0
Cedar Landing	16.0	Rogers Cut (south end)	47.2
Little Jam Log Point	16.9	Stuart Creek Landing	47.9
Big Jam Log Point	17.1	Chitty Avenue	48.1
Agnew Landing	17.6	Palmetto Grove	48.4
Sims Landing	18.2	Longs Landing	49.2
Turkey Creek (east end)	18.3	Shingle Mill	49.3
Turkey Foot Landing	18.5	Graham Landing	49.6
Turkey Creek (west end)	18.8	Grahamsville	50.5
Black Hawk Bend	19.4	Howard Landing	51.7
Fort Burke	20.1	Delk Bluff	52.8
Jordan Landing	20.8	Silver Spring Run	53.1
Orange Creek	21.1	Ferry	55.5
Needle Eye	21.4	Prairie	57.5
Gray Cut	22.2	Heather Island Landing	58.9
McBride Landing	22.9	Ferry	59.3
Will Landing	24.5	Twin Cypress	63.2
Twin Palmetto	24.9	Clifton Landing	64.0
Long Reach	25.0	Fort Field	67.4
Dean Grove	26.5	Moss Bluff	70.3
Pain Landing	27.1	Pine Bluff	76.2
Douglass Landing	27.8	Stark Shoal (north end)	79.6
Iola	28.2	Stark Shoal (south end)	80.7
Wells Grove	29.5	Stark Landing	81.0
Forty-Foot Bluff	29.9	Ferry	81.3
Wild Cat Jump	31.1	Umbrella Island	85.0
Rough and Ready Cut	31.5	F. S. R. R. Steamboat Wharf	85.2
Eureka Cut-off	33.5	Hog Island	85.6
Meigs Landing	34.0	Lake Griffin	86.2
Eureka	34.3	Leesburg	94.0

Digitized by Google

TABLE NO. III.

Section number.	Average width.	Least width.	Average depth.	Least depth.	Number of snags.	Number of overhanging trees.	Number of bends.	Velocity of current per hour.
	Feet.	*Feet.*	*Feet.*	*Feet.*				*Miles.*
1	100	60	14	5	23	.....	48	0.7
2	60	30	10	4	30	9	56	0.6
3	100	60	12	5	20	43	45	0.7
4	75	50	11	5	41	144	43	0.8
5	70	35	12	5	60	81	57	0.9
6	75	50	12	5	40	54	41	0.9
7	60	22	10	4	52	49	65	0.9
8	60	40	11	6	81	35	61	0.95
9	55	35	8	4	61	25	65	0.95
10	75	50	10	5	60	12	57	0.95
11	65	30	10	5	52	28	61	0.97
12	60	40	8	5	78	34	63	0.6
13	40	30	9	5	.....	.....	72	0.4
14	40	35	9	5	.....	.....	73	0.4
15	35	30	8	5	.....	.....	72	0.4
16	150	60	7	5	.....	.....	36	0.4
17	500	100	8	5	.....	.....	19	0.4
18	.....	.....	.....	8	.....	.....	.....	0.4

REMARKS IN CONNECTION WITH TABLE NO. III.

Sec. 1. Section in fairly good condition. Considerable grass in western end.
2. The Narrows, 2¼ miles long, are in very bad condition, narrow, very crooked, full of snags and overhanging trees, shallow, and full of grass. The current is slack here.
3. This section is wide and comparatively straight. In fairly good condition.
4. This section is crooked and in bad condition.
5. This section is in a very bad condition.
6. Long and comparatively straight reaches. In fairly good condition.
7. Eureka Cut-off, 1½ miles long, at south end of section. Is very narrow, shallow, full of snags and overhanging trees.
8. The south end of this section is very crooked and in bad condition.
9. Narrow and in bad condition.
10. In fairly good condition.
11. From Silver Spring Run south the river is in very bad condition, narrow, shallow, filled with tree tops and snags. Current becomes less rapid south of Silver Spring Run.
12. The south end of this section is in the prairie. There are no snags, but the river is narrow (not more than 40 feet wide). The north end of section is in bad condition.
13. In the prairie.
14. Very crooked.
15. This section is filled with grass and the southern end is blocked with floating islands for a distance of 250 feet.
16. Reaches are straight and river widens to 250 feet at south end of section.
17. Many floating islands are forming in the middle part of this section. The river widens to 700 feet at southern end of section.
18. Lake Griffin, 7.5 miles long; average width, 2 miles.

GENERAL DESCRIPTION OF THE RIVER.

As before stated, for a distance of 28 miles from Lake Griffin the river flows through a prairie or marsh covered with a growth of saw-grass. The impediments to navigation in this portion of the river are the numerous bends, narrow channel, floating islands, and eel-grass. There are no snags or overhanging trees.

As a rule, the river is very crooked. The available mid-channel depth at ordinary low water is 5 feet; the average width is from 30 to 40 feet.

From Lake Griffin to within a mile of Starke's Landing the bank on either side is a floating marsh with very irregular edges. This marsh is covered with a growth of saw-grass and lily pads, whose roots form a solid homogeneous mass about 2 feet thick. When the river rises the edges of this marsh break away and float down the river, forming what are called floating islands. These islands become jammed together, usually at the first sharp bend or shoal, and navigation is completely stopped. The progress of the survey was stopped at a point about 2 miles below Pine Bluff.

Digitized by Google

where there were several packs of these floating islands inside the space of 1 mile of river.

Before navigation can be resumed, these packs must either be cut away in piecemeal or each island must be towed down stream to a suitable point and fastened to the river bottom by stakes. As long, however, as these islands are allowed to enter the narrow river, they will stop it up at some point.

The eel-grass offers no obstruction to stern or side wheel boats, but is a serious impediment to propellers. It is a long narrow grass, deriving its name from its appearance. It covers the river bottom, except in spots, throughout the entire length. In shoal places, not constantly traversed by boats, it floats on the surface, and is a source of delay and annoyance. It can be most economically removed by simply running a propeller through it, tearing it out by the roots.

The only landing on this portion of the river not having a daily steamboat service is Moss Bluff, a settlement of about 300 people. A small steamboat makes weekly trips between this landing and Grahamsville.

Nearly all the freight, as well as the mail, is brought by stage from the Southern Florida Railway, which is only 4 miles distant. Starke Landing and Umbrella Island Landing, on the upper end of the river, have a daily steamboat service from Leesburg.

From the prairie to Silver Springs Run, a distance of about 5 miles, the river flows through a cypress swamp and is filled with snags and overhanging trees.

Permanent improvement of the river between Lake Griffin and Silver Springs Run would enable the orange and vegetable growers in the vicinity of Lake Griffin to ship their produce by water from Leesburg to the St. Johns River. Considering the high rate of freight charged by the railroads, this improvement would probably be of great benefit to the farmers of this section.

The improvement recommended consists in—

1. Removing the floating islands now obstructing the river.

2. Fencing in the channel from Lake Griffin for a distance of about 4 miles down stream, with the object of preventing the floating islands from getting into the channel. The construction recommended for this fence consists in a row of piles on each side of the channel, with an interval of about 15 feet between each pile. The piles would be connected by planks 2 by 12 by 20, placed just above the low-water line.

3. Removing the worst snags and overhanging trees in the river between the prairie and the Silver Springs River.

The estimate for improving this portion of the river is as follows:

Removing floating islands	$300
1,600 piles, at $3 (for channel fence)	4,800
84,000 feet B. M. lumber, at $25 per M	2,100
Removing 101 snags, at $4	404
Removing 56 overhanging trees, at $3	168
Engineering and contingencies (10 per cent.)	678
Total	8,450

The lower river, like the upper river, is very crooked and can be navigated safely only by stern-wheel boats, having their wheels boxed in on the sides and bottom and their rudders so hung that the water from the wheel is forced against it. This construction is necessary on account of the danger of breaking the wheel by running on snags and into the densely wooded banks, and on account of the difficulty of bringing the boat around the sharp bends.

The only improvement recommended in this portion of the river consists of removing the worst snags and overhanging trees. Nearly all of these snags consist of the tops of trees felled deliberately in the river by lumbermen and of logs which have become detached from their rafts. These logs are apt to settle down one end in the mud and the other end reaching to within a short distance of the surface. In this position they form the most dangerous snags. I should recommend that some measures be taken to prevent the lumbermen from obstructing the river before the improvement be commenced.

The estimate for improving the lower river is as follows:

Removing 507 snags, at $4	$2,028
Removing 458 overhanging trees, at $3	1,374
Engineering and contingencies (10 per cent.)	340
Total	3,742
Estimate for upper river	8,450
Grand total	12,192

Digitized by Google

I submit herewith the following papers:

1. Map, scale $\frac{1}{20000}$.
2. Map, scale $\frac{1}{10000}$.
3. One photograph of the pontoon.

Very respectfully, your obedient servant,

J. H. BACON, *Assistant Engineer*

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commerce of Ocklawaha River, Florida, during the year ending December 31, 1890

Article.	Quantity.	Estimated value.	Gross tonnage
Cotton ..... bales..	494	13,835	
Fertilizers ..... tons..	160	4,000	
Fruits ..... boxes..	33,410	66,820	1
Grain ..... bushels..	14,870	17,100	
Hides ..... number..	300	150	
Honey, sirup, etc ..... gallons..	2,200	1,100	
Lumber:			
Rough ..... feet..	7,500,000	45,000	75
Sawed ..... B. M..	2,066,000	41,320	4
Merchandise ..... tons..	532	26,600	
Ship stores ..... barrels..	488	700	
Vegetables ..... boxes..	1,095	1,259	
Breadstuffs ..... tons..	105	5,250	
Total	.....	223,134	81

Vessels.	Average tonnage.	Average draft of water
Steamboats:		Feet
Eureka	67	
Okahumpkee	65	
Osceola	60	
Marion	50	
Astatula	55	

Passengers: Number carried, 17,000; revenue received from same, $46,000.

Estimated percentage of total trade of neighborhood carried by water, 50 per cent.

Probable increase of trade were the improvement completed, 50 per cent.

Remarks.—The Ocklawaha River is the main water way for a large area of country much of which is devoted to fruit and vegetable culture.

Owing to the beauty of its tropical scenery, the river has become a favorite resort for visitors during the winter months.

During the fruit season a line of light-draft boats makes regular trips between Palatka, on the St. Johns River, and Silver Springs, on a branch of the Ocklawaha River. The upper portion of the river, to Leesburg, and also into Lakes Dunn and Griffin, and others, is now completely closed to navigation by the accumulation of saw-grass and "flood trash." It is of vast importance to this section that a channel for small boats of 75 to 100 tons, with a draft of from 4 to 6 feet, be opened from these lakes into the Ocklawaha. The exorbitant rates charged for freight on fruit and vegetables by the railroad companies has a tendency to retard the growth of the country, as well as to hold back much of the crops. Under existing conditions growers have not been able to realize a profit on shipments of fruits, etc., to New York.

It is thought that the opening of the upper river to Leesburg and the adjoining lakes would cause fully 50 per cent. of the tonnage now carried by rail to go through the Ocklawaha River into the St. Johns for reshipment at Jacksonville.

Digitized by Google

To accompany Annual Report of 1891

W. M. Black.

Capt, Corps of Engrs U.S.A.

Digitized by Google

Digitized by Google

Following is a statement of the business on the lakes at the upper end of the Ocklawaha River for the year 1890, kindly furnished by Mr. Thomas C. Lanier:

Articles.	Quantity.	Estimated value.	Gross tons.
Cotton ..... bales..	2	$80	½
Fertilizers ..... tons..	250	6,250	250
Fish and oysters ..... barrels..	5	20	1
Fruits ..... boxes..	40,000	80,000	1,600
Grain ..... tons..	200	17,000	200
Hides ..... do...	5	1,000	5
Honey, sirup, etc ..... do...	1	400	1
Lumber:			
Rough ..... feet..	50,000	5,000	100
Sawed ..... B. M..	2,500,000	50,000	5,000
Merchandise ..... tons..	5,000	375,000	5,000
Ship stores ..... barrels..	10	70	1
Vegetables ..... boxes..	20,000	20,000	1,000
Total	.....	554,820	13,158½

I think fully 50 per cent. of the above freight would go by water to market. The roads have been so extravagant in their charges this past winter and spring that the people would patronize steamers on water, unless the roads would fall 50 per cent. on their present charges.

The business of this section is growing rapidly and will be enormous in a few years. One acre of orange trees in full bearing will make as much or more freight than 100 acres in cotton.

My estimates go from Lake Dun to the north end of Lake Griffin.

The State railroad commission is now abolished and our only hope of relief is the water arteries that God made and left for us to improve.

The importance of further improvement is evident.

CHAS. R. HILL.

O 3.

IMPROVEMENT OF VOLUSIA BAR, FLORIDA.

Operations for improving Volusia Bar, Florida, have been carried on at intervals since December, 1880, under seven appropriations, aggregating $26,000.

Volusia Bar is located at the south end or head of Lake George, about 162 miles by river from the mouth of St. Johns River, at the point where the waters of the river flow into the lake.

An examination of Volusia Bar with a view to its improvement was made in March, 1879. A report thereon, dated July 16, 1879, with plan of improvement, is printed as Appendix I 9, Annual Report of the Chief of Engineers for 1879.

This was modified as reported in the Annual Reports of the Chief of Engineers for 1882 and 1883, Appendixes J 11 and L 14, respectively.

Before its improvement the channel over the bar was very crooked and had a least depth varying from 3½ to 4¼ feet.

APPROVED PROJECT.

To establish and maintain a channel 6 feet deep across the bar by the increased velocity of flow produced by two converging jetties of brush and stone, assisted by dredging if necessary, and to define and protect the channel thus formed by rows of fender piles.

In 1887, this project was modified to limit the depth to the 5 feet already attained, as that depth is sufficient for the steamers navigating

Digitized by Google

the Upper St. Johns River and is as great as can be carried over the bar between Lake Monroe and Lake George.

OPERATIONS PRIOR TO JUNE 30, 1890.

The total amount expended up to June 30, 1890, including liabilities then outstanding, was $25,481.77. Two jetties had been built, starting from opposite sides of the river bank at the south edge of the lake and converging until on the bar the clear channel way between them was 230 feet wide. The east jetty is 3,400 feet long, and is built to the level of mean low water for 2,930 feet from the shore. The west jetty is 2,200 feet long, of which a length of 1,940 has its crest at the level of mean low water. Two rows of firmly set piles, provided with waling strips, confine boats to a 100-foot channel across the crest of the bar. In 1887 the depth attained was reported to be ample for the existing commerce.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1891.

In the act approved September 19, 1890, $500 were appropriated for the maintenance of the work. An examination of the bar was made in January, 1891, and again in July, 1891, 175 tons of rock were ordered for the repair of the jetties, and on June 30 the delivery had been partly completed.

WORK REQUIRED.

The St. Johns River above Lake George is a silt-bearing stream, having eroding banks, pools, and shoals, and is subject to marked fluctuations of level. Lake George forms a settling basin and receives an annual deposit from the materials eroded between Lakes George and Monroe, a distance of 45 miles. The greater portion of this material is deposited at the head of the lake, where the river currents lose velocity in entering the broader expanse, and there forms and maintains Volusia Bar. It is evident that any increase of depth produced by contraction and scour in a bar of this character will simply push the deposit farther out into the still water. If the depth of the lake where the new deposit is formed were great, the improvement of the channel by unassisted jetties might have some permanence.

Lake George is very shoal. In 1887 the least channel depth was reported to be 5 feet; the 6, 7, and 8 foot contours of the bottom were 420, 780, and 1,440 feet, respectively, from the ends of the jetties and at the distance of 3,400 feet beyond the jetties a maximum depth of 9.6 feet only was found. In 1891, the least channel depth is 4.6 feet and the 6, 7, and 8 foot contours 375, 480, and 1,175 feet, respectively, from the ends of the jetties.

Commerce has been greatly hampered by boats grounding on the bar during the past low-water season. Further improvement of the bar is required. Only temporary relief can be obtained by an extension of the jetties.

The best and surest method to adopt will be to deepen the channel by dredging from time to time as may be needed.

From past experience it would seem that the annual deposit on the bar is about 500 cubic yards. If there were any plant available this could be removed with an annual expenditure of $500. As there is no dredging plant available at present in this vicinity, the cost of the work by contract would be more than double, if indeed any bids could be

Digitized by Google

obtained. As work is also urgently needed on the Upper St. Johns River, as reported in letter dated January 26, 1891, printed in Ex. Doc. No. 240, H. R., Fifty-first Congress, second session, and for which the sum of $4,930 is now available, it would be a great advantage for the United States to own a properly equipped snag and dredge boat for operations on the entire river. Such a boat could be obtained for $15,000. She could be operated at a cost not exceeding $800 per month.

During the past winter the commerce of the upper river was greatly increased, and the indications point to a further increase of both freight and passenger traffic if the river can be navigated without the vexatious delays caused by the grounding of the boats.

Money statement.

July 1, 1890, balance unexpended	$45.48
Amount appropriated by act approved September 19, 1890	500.00
	545.48
June 30, 1891, amount expended during fiscal year	41.35
July 1, 1891, balance unexpended	504.13
July 1, 1891, outstanding liabilities	168.75
July 1, 1891, balance available	335.38
Amount (estimated) required annually for maintenance of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	1,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Commerce of Volusia Bar and Upper St. Johns River, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons	4,560	$136,800	4,560
Fruits ..... boxes	155,600	311,200	6,224
Hides ..... number	2,000	1,400	20
Merchandise ..... tons	7,800	585,000	7,800
Vegetables ..... boxes	33,000	39,600	1,650
Total		1,074,000	20,254

Vessels.	Character.	Average tonnage.
H. B. Plant	Side wheel	300
Everglade	Stern wheel	420
DeBary	Side wheel	300
Welaka	Stern wheel	300
Crescent City	Side wheel	200
City of Jacksonville	Side wheel	460
Governor Stafford	Side wheel	300

Average draft of water, 3½ feet.

Passengers: Heavy passenger travel. No estimate can be formed.

Remarks.—The decrease in the tonnage of vegetables shipped is caused by the high freight rates charged by the railroads north of Jacksonville on produce destined for New York, and also to continued severe frosts in the early part of the growing season.

Digitized by Google

It is the opinion of those interested in navigation over this bar that a greater depth of water would materially increase the north-bound tonnage, as at present it is not possible to load boats to their full capacity.

Nearly the entire trade of the neighborhood is carried by water and passes over Volusia Bar.

CHAS. R. HILL.

O 4.

IMPROVEMENT OF ST. AUGUSTINE HARBOR, FLORIDA.

St. Augustine Harbor lies on the east coast of Florida, about 47 miles south of the St. Johns River. It is formed by the junction of two rivers, or rather salt-water lagoons, the Matanzas and Tolomato rivers, which run parallel to the coast, and there unite to break through the line of sand-hills into the sea. The total length of the Tolomato River is about 20 miles, and of that part of the Matanzas River which receives and discharges across the St. Augustine Bar, 12 miles. The San Sebastian River, another lagoon, almost surrounds St. Augustine, and opens into the Matanzas River about 3 miles from its mouth. These lagoons vary in depth from 20 to 30 feet for several miles from the mouth, and in width from 300 to 500 yards. They form large tidal basins, filled and emptied through the channels across the bar. The rise of tide at St. Augustine varies from 4 to 6 feet, and the currents generated have maintained two or more channels across the bar with a least depth of from 6 to 9 feet at low water. The positions of these channels are continually shifting between the south end of the mainland east of the Tolomato River (north beach or north point), and the cape on Anastasia Island 2¾ miles to the south. The harbor forms an excellent sheltered anchorage, but the shifting nature of the bar and the shallow water on its crest have presented so many difficulties to mariners that the commerce of the port has been greatly hampered. It is limited practically to the necessary supplies for St. Augustine.

Two appropriations, aggregating $55,000, have been made for this harbor, which have been used for protecting the shores at the entrance from erosion.

PROJECT.

The approved project is to protect the shores from erosion by the construction of groins of concrete and riprap on brush foundation mattresses.

OPERATIONS PRIOR TO JUNE 30, 1890.

With the appropriation of $35,000 made in the act of 1888, 3 groins were built: No. 1, on Anastasia Island, near the northern boundary of the United States Light-House Reservation; No. 2, on North Beach, at the point; No. 3, on North Beach, about 2,000 feet from the point.

These groins all consist, essentially, of a foundation of brush fascines, covered with riprap and capped with concrete blocks which are 2 feet wide on top and have side slopes of 1 on 2. (For detailed description of dimensions and methods, see Appendix P 3, Report of the Chief of Engineers, 1890.)

Digitized by Google

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1891.

Twenty thousand dollars were appropriated for the improvement in the act of September 19, 1890. Work by hired labor was begun in December and was stopped, owing to the small amount of the appropriation remaining, on May 29, 1891.

Groin No. 2 was extended seaward and two new groins were built, No. 4 on Anastasia Island, about 2,200 feet northwest of groin No. 1, and No. 5, on North Beach, between groins Nos. 2 and 3. Excepting in minor details, the groins are like those constructed earlier and described in the last annual report.

Groin No. 4 is 523½ feet long. From station 0 to station 165½ the concrete blocks are rectangular in cross section, 4 feet wide and 2.8 feet thick, and with their top surface 9.0 feet above mean low water. From station 165½ to the end the blocks are 3 feet thick, 6 feet wide at base, 2 feet wide on crest, with side slopes of 1 on 1, stopping at a height of 1 foot from the base. The crest of this portion of the groin slopes from reference 9.0 to reference 2.5 feet. Twenty thousand six hundred linear feet of 9-inch brush fascines, 1,447 tons (2,000 pounds) of stone, and 249.3 cubic yards of concrete were used in this groin.

Groin No. 5 is 465 feet long and is in general similar to groin No. 4. From station 0 to station 79 the concrete blocks are rectangular in cross section, and are 4 feet wide and 2 feet thick. The crest of this portion of the concrete capping is 8.9 feet above mean low water.

From station 79 to station 214 the concrete blocks are 3 feet thick, 6 feet wide at the base, and 2 feet on the crest, and have side slopes of 1 on 1. The crest of this part of the groin slopes from reference 8.9 to reference 5.9 above mean low water. From station 214 to the end the concrete blocks have the same top width and side slopes as before; but the thickness is 4 feet and the width at the base is 8 feet. The crest of this portion of the groin varies from 5.9 to 5.3 feet above mean low water.

Twelve thousand seven hundred linear feet of 9-inch brush fascines, 686.7 tons of stone, and 296.3 cubic yards of concrete were used in the construction of this groin.

At the close of the work under the first appropriation a small number of light concrete blocks weighing 4,751 pounds, wet, in air, had been placed in the riprap at the end of groin No. 2. These were displaced by wave action during the past season. They were removed and the new capping was begun where they had started, and the groin with the capping was extended 162.5 feet to station 415. The new concrete blocks are 7.5 feet long, 8 feet wide at the base, 2 feet wide on top, and 3 feet thick. The side slopes are two on three. The crest of this portion of the groin slopes from reference 5.5 to reference 3.1. Four thousand three hundred linear feet of 9-inch brush fascines, 357 tons of stone, and 112.4 cubic yards of concrete were used in this groin under this appropriation.

METHODS.

The methods employed were similar to those described in Appendix P 3, Report of the Chief of Engineers, 1890, except that the boxing was provided with a bottom of 1-inch plank. In each case the foundation mattress, with its riprap ballast, extends from 40 to 60 feet beyond the end of the superstructure.

Saylor's American Portland cement was used in all of the concrete placed during the year. At first it was mixed in the proportions of 1

Digitized by Google

cement, 4 sand, and 6½ coquina gravel, which had given good results with the Portland cements used the year before. This was, however, found to be too weak and a portion of the concrete was lost, as described hereafter. The proportions were then increased to 1 cement, 3 sand, and 5 coquina gravel, which gave fairly good results. In the outer blocks of groins 4 and 5 the concrete was enriched to the proportions of 1 cement, 2 sand, and 4 coquina gravel. This concrete is good.

In all of this work where wave action was heavy good results were obtained only with concrete which rapidly (within 48 hours) attained a tensile strength of 30 pounds per square inch, and this even with boxing so tight that currents alone had no effect.

Statement of cost of concrete per cubic yard, St. Augustine Harbor, 1891.

Locality.	Materials.											Per yard of concrete.
	Cement.				Shell and sand.		Lumber.			Nails.		
	Total amount of concrete.	Barrels.	Total cost.	Per yard of concrete.	Total cost.	Per yard of concrete.	Total amount B. M.	Total cost.	Per yard of concrete.	Total.	Total cost.	
	Cu. yds.									*Lbs.*		
North beach	410.0	502½	$1,409.66	$3.44	$307.38	$0.75	18,250	$208.64	$0.51	600	$15.35	$0.
South beach	249.3	324	944.32	3.79	146.16	.58	13,790	193.20	.78	450	11.75	

Locality.	Labor.									Per yard of concrete.
	Boxing.		Mixing and ramming.		Handling cement.		Superintendence.		Transportation.	
	Total cost.	Per yard of concrete.	Total cost.	Per yard of concrete.	Total cost.	Per yard of concrete.	Total cost.	Per yard of concrete.	Total cost.	
North beach	$337.82	$0.82	$636.27	1.55	$45.25	$0.11	$144.61	$0.35	$60.23	$0.
South beach	147.28	.59	294.27	1.18	68.84	.27	85.34	.34	38.21	

Cost of concrete per cubic yard.

	North beach.	South beach.
Materials:		
Cement	$3.44	$3.
Shell and sand	.75	
Lumber	.51	
Nails	.04	
Labor:		
Boxing	.82	
Mixing and ramming	1.55	
Handling cement	.11	
Superintendence	.35	
Transportation	.15	
Total	7.72	7.

NOTE.—In the above table is included the cost of all repairs to groin No. 2, and the cost of all concrete lost by being washed out by waves before having set.

Digitized by Google

Cost of various operations, St. Augustine Harbor, 1891.

Locality.	Making fascines.			Handling rock.			Shell and sand.			Making mattresses.			Handling cement.		
	Total linear feet made.	Total cost.	Cost per 100 feet.	Total tons.	Total cost.	Cost per ton.	Total amount in yds.	Total cost.	Cost per cubic yard.	Total square yards of fascine mats.	Total cost handling and making mats.	Cost per square yard of fascine mat.	Total No. of barrels.	Total cost.	Cost per barrel.
North Beach	17,000	$583.43	$3.14	1,043.7	$475.04	*$0.45½	518	$307.38	$0.59	1,889	$421.62	$0.22	502½	$45.25	‡0.09
South Beach	29,600	654.81	3.18	1,447.0	30.91	†0.02½	342	146.16	.43	1,526	283.58	.19	324	68.84	§0.21

*Stone was hauled several hundred feet in a tram-car and then wheeled out on groin.
†Stone was dumped from contractor's scows on the groin.
‡Cement was floated from town on lighter and hauled across beach in tram-car and stored.
§Cement received above handling, and in addition had to be reloaded on lighter and taken across the beach and stored.

CONDITION OF THE GROINS.

The groins completed prior to June 30, 1890, with the exception of the outer end of No. 2, previously mentioned, are in perfect condition and have undergone no settlement or displacement.

All of the work done during the year ending June 30, 1891, is also in excellent condition; but when first built some trouble was experienced with a part of the concrete capping of the extension of groin No. 2. In some of the blocks cracks from 2 to 8 inches deep opened along the crests and sides in 2 or 3 weeks after the blocks were finished. These cracks were generally parallel to the axis of the groin. The pieces of concrete included between any two of these cracks generally flaked off in a short time after the cracks developed, owing to the action of the waves, assisted, apparently, by some internal force tending to push outward and in a direction normal to the surface of the block.

While this action was very annoying and injured the appearance of the capping, it did not extend to a sufficient depth to injure the work to any extent. The cracks did not increase after the first month. The pieces of concrete which flaked off have all been replaced by a mortar of cement and sand, and the work is now (5 months later) in good condition.

WAVE ACTION.

Wave action was severe during the progress of the entire work on North Beach, a dynamometer in the vicinity giving at one time a reading corresponding to a pressure of 831 pounds per square foot while concrete work was being carried on. At groin No. 4, on Anastasia Island, wave action was less severe.

Lieutenant Gaillard's detailed report of observations on wave action is appended. Evidence of the greatest wave action was seen at the outer extremity of groin No. 3. At this point the side of the groin between reference 1 and reference 5 was formed by a block 10 feet long, with the cross section normal to the jetty axis, trapezoidal in form, having a base 6 feet wide and vertical sides 1 and 4 feet high. The base was at the reference 1. The exposed surface had a slope of 1 on 2, both vertical faces and the outer end face being protected by other portions of the groin. This block, whose weight in air, wet, is 21,000 pounds, was lifted vertically 3 inches and there held. The maximum

Digitized by Google

dynamometer reading at this point for the time during which th action took place corresponded to a pressure of 633 pounds per squa foot, and the height of water surface varied from 0 to 5½ feet, the refe ence of the sand at the jetty base being 0.5. Hence the maximu depth of water at the block could not have exceeded 5 feet at any tim The block had been in place without movement for over 4 months, an has not been moved in the past 7 months.

In general, where waves did not break and fall directly upon it, ver light riprap (one man stone) stood at a height of 1 foot above mea low water; above this height, or where the waves broke and fell, eve 2-ton rectangular blocks were moved easily. Everywhere the light ri rap remained in place up to the level of low water.

EFFECT OF THE GROINS.

A survey made on June 23, 1891, shows the effect of the groins to b as follows:

Groin No. 1, Anastasia Island, has completely stopped the erosio in its vicinity and has pushed the shore high-water line seaward 5 feet on an average, for a distance of 1,200 feet north of the groin an 450 feet south. The low-water line along the same portion of the shor has been pushed seaward an average distance of 80 feet.

Groin No. 4, Anastasia Island, has stopped the erosion in its imme diate vicinity, but having been completed only about a month, it ha as yet pushed the high and low water lines seaward only a few feet i the vicinity of the groin.

Groins Nos. 2, 3, and 5, North Beach, have checked the washin away of the point, and have built out both the high and low wate lines. Commencing at a point 2,250 feet north of groin No. 3, and ex tending around the point a distance of 4,050 feet, the high-water lin has been pushed seaward a distance varying from 0 to 200 feet, and the low-water line varying from 0 to 350 feet.

FUTURE OPERATIONS.

With the amount on hand and the $10,000 included in the estimate of May 24, 1890, and not appropriated in the act of September 19, 1890, it is believed that the improvement now contemplated can be completed.

The work has been efficiently and economically carried on under the immediate direction of Lieut. D. D. Gaillard, Corps of Engineers, assisted by Mr. F. W. Shepard, superintendent.

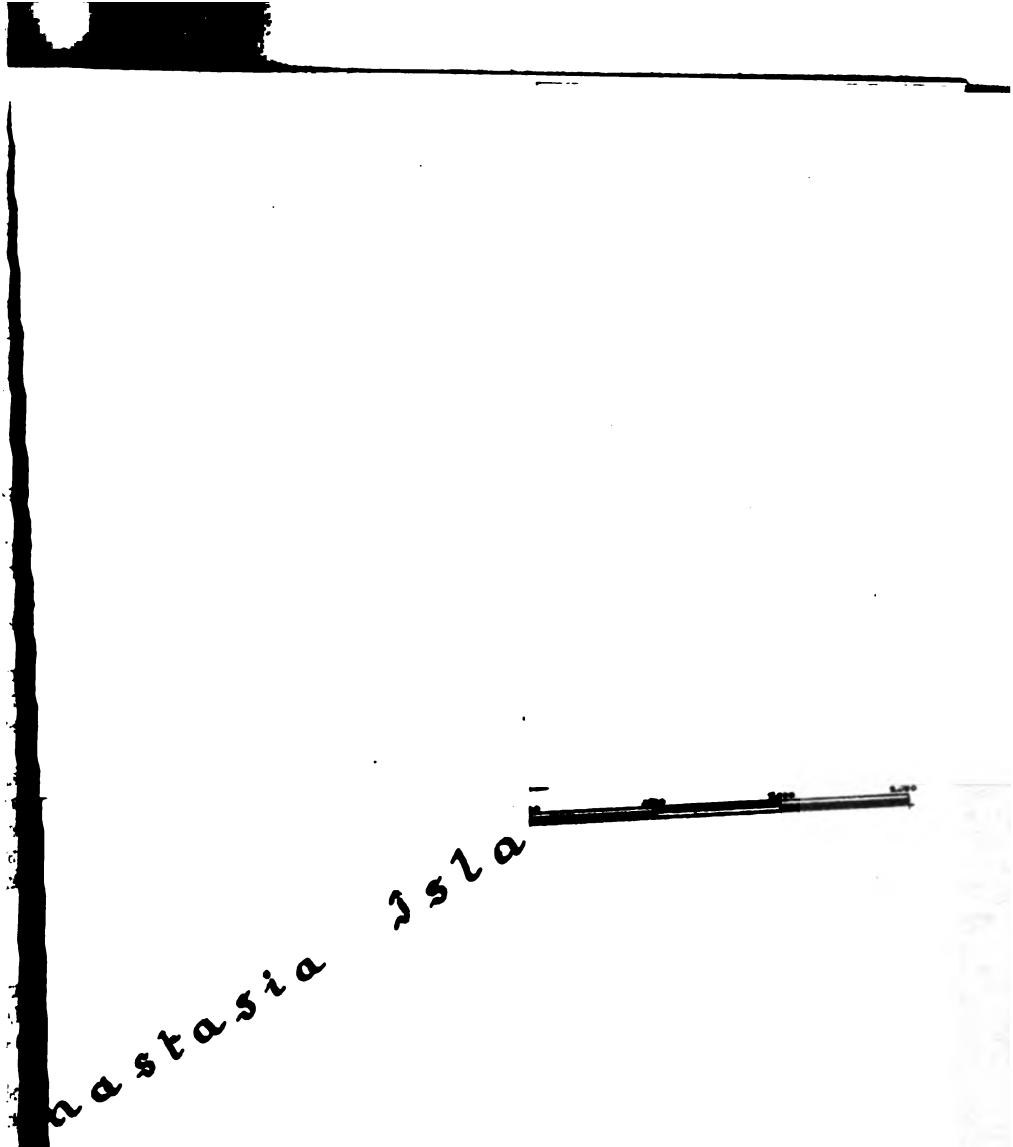
St. Augustine is in the collection district of St. Augustine, which is the nearest port of entry. The nearest fort is Fort Marion. The St. Augustine Light is the nearest light-house.

A map of the harbor showing protecting works and a report on wave action by First Lieut. D. D. Gaillard, Corps of Engineers, accompanies this report.

Money statement.

July 1, 1890, balance unexpended	$1,682.14
Amount appropriated by act approved September 19, 1890	20,000.00
	21,682.14
June 30, 1891, amount expended during fiscal year	17,570.02
July 1, 1891, balance unexpended	4,112.12
July 1, 1891, outstanding liabilities	149.68
July 1, 1891, balance available	3,962.44

Digitized by Google



Digitized by Google

Digitized by Google

Amount (estimated) required for completion of existing project..... $10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing stone for use in connection with improving harbor at St. Augustine, Fla., received in response to circular letter dated November 12, 1890, and opened December 3, 1890.

No.	Name of bidder.	Stone on Anastasia Island.						Stone on North Beach at the point, per ton of 2,000 pounds.			Grand total.
		On wharf at West terminus South Beach Railroad, per ton, of 2,000 pounds.			At a point on shore about ¼ mile northwest of jetty, per ton of 2,000 pounds.						
		Estimated quantity required.	Price per ton.	Total.	Estimated quantity required.	Price per ton.	Total.	Estimated quantity required.	Price per ton.	Total.	
1	James B. Brown	1,400	$2.80	$3,920	1,400	*$2.90	$4,060	1,100	$2.80	$3,080	$7,140
2	R. G. Roest	1,400	no bid.		1,400	*2.90	4,060	1,100	2.70	2,970	7,030
3	Marcus Conant	1,400	2.97	4,158	1,400	2.97	4,158	1,100	2.97	3,267	7,425

*Most advantageous bid for Anastasia Island.
†Lowest bidder.

Total amount available for work December 3, 1890, exclusive of outstanding liabilities, $7,500. Recommended that bid No. 2 be accepted.

OBSERVATIONS ON WAVE ACTION AT ST. AUGUSTINE HARBOR, FLORIDA.

During the progress of the work of shore protection at this harbor by means of concrete groins, unusual facilities were afforded for observing, not only the effect of the waves on the work itself, but also on dynamometers placed in the immediate vicinity in various depths of water and at various elevations above the water surface.

LOCALITY.

At the locality where the observations were made the shore line is straight and trends N. 13 W. The bottom is hard, smooth, and regular, and the depth from the shore seaward increases very gradually and uniformly, being 5 feet at 500 feet from shore; 10 feet at 1,700 feet; 15 feet at 3,300 feet; 20 feet at 5,500 feet, etc.

As a result of the foregoing causes the direction of travel of the waves is nearly always normal to the shore line, and, except in heavy weather, the breakers, into which they are transformed on approaching the shore, are quite regular, and their heights from hollow to crest and their velocities can be easily measured by means of graduated stakes set near the groins. It is to these shore breakers exclusively that the observations apply.

The period during which observations were made extended from October 1, 1889, to June 3, 1891.

VELOCITY OF WAVES IMMEDIATELY BEFORE BREAKING.

Owing to the small slope and uniform character of the bottom, the form of the wave and its velocity underwent little change during the time occupied in traveling over the last 50 or 100 feet before breaking.

In all, nearly one hundred observations for velocity were made on waves varying in height, at the instant of breaking, from 2 inches to 7 feet, between hollow and crest.

Those observations were selected which were taken during calm weather, or when only moderate winds prevailed, in order to eliminate the effect of this element. They are shown in the following table:

Digitized by Google

TABLE I.—*Velocity of waves, in shallow water, immediately before breaking.*

Height of wave from hollow to crest.	Number of observations made.	Observed velocity in feet per second.	Computed velocity in feet per second.
2 inches	2	1.7	1.3
3 inches	2	2.3	2.1
4 inches	2	2.5	2.5
6 inches	4	2.8	3.3
8 inches	2	4	4
10 inches	2	5	4.7
1 foot	5	5.4	5.3
1.25 feet	5	6.8	6.1
1.5 feet	3	7	6.9
1.7 feet	1	8	7.5
2 feet	4	8.4	8.4
2.25 feet	4	9.4	9.1
2.5 feet	10	9.4	9.7
2.75 feet	5	10.3	10.4
3 feet	6	11.7	11
4 feet	10	12.2	13.3
4.25 feet	2	13	13.8
4.5 feet	4	14	14.4
5 feet	8	15.2	15.4
6 feet	2	18.2	17.4
7 feet	1	21.5	19.3

REMARKS.—The observations were made during the period between January, 1890, and May, 1 and were all taken in the vicinity of groin No. 3, North Beach, St. Augustine Harbor, Florida.

It was found that for this particular locality the velocity was given fairly well the equation, $y = .08242\, x^{\frac{3}{2}}$; in which y is the height from hollow to crest in f and x is the velocity in feet per second. For the purpose of comparison the c puted velocities for similar waves are given in the fourth column of the preced table. There is but little doubt, however, that the velocity is considerably affec by the locality, and it is not likely that this equation could be used to advant elsewhere in its present form.

When the wind was in the direction of wave travel the velocity was increas and when it was in the contrary direction the velocity was decreased. In the fi case the increase was greater, relatively, the smaller the wave; while in the seco case the decrease was greater the larger the wave.

This is doubtless due to the fact that the velocity of the larger waves is great and consequently the wind pressure on the windward side is less than with t smaller waves when traveling with the wind, and greater when traveling agai it.

As no anemometer was available it was impossible to measure the wind effe even approximately.

DEPTH OF WATER IN WHICH WAVES BROKE.

Fifty-eight observations on waves, varying in height from 4 inches to 6 feet, we made in order to determine accurately, if possible, the relation of the wave heig to the depth of water (if undisturbed by waves) in which the waves broke.

Denoting this depth by d and the height of the wave at the instant of breaking l h, and considering all of the observations taken, it was found that d varied betwe the limits 0.72 h and 2 h, but that for the greater number of the observations d w equal to h.

For a given locality variations in the ratio of d to h seemed to be caused entirel by the direction and force of the wind. With a strong, favorable wind d becam equal to 1.25 h, while with about an equally strong contrary wind, at the same loca ity, d was equal to 0.72 h. When there was little or no wind and the breakers wer due to the ordinary ocean swell, the ratio of d to h varied almost entirely with th slope of the bottom. For example, when the bottom was uniform and this slop was about $\frac{1}{100}$, d was nearly always equal to h, but when this slope was about $\frac{1}{20}$ became equal at times to 2 h.

As few, if any, engineering works in common use give a less value for d than d = h, it may be well to state that there were in all 10 carefully taken observations i which d was found to be less than h.

Digitized by Google

RELATION OF HOLLOW AND CREST OF WAVE, AT BREAKING, TO UNDISTURBED WATER SURFACE.

To determine the relative positions of the hollow and the crest of the wave with reference to the water surface, 45 observations were taken on waves varying in height from 2½ to 6 feet immediately before breaking. These observations were all taken at the locality first mentioned in this report.

Denoting the wave height by h and the reference of the crest above the water surface by c, it was found that c varied between the limits $c = .67\ h$ and $c = .89\ h$; the mean value being $c = .76\ h$.

With a flat slope of the bottom, or an opposed wind, c was increased, while with a steep bottom slope or a favorable wind c was decreased.

DYNAMOMETER RECORD.

The dynamometers used have been fully described on pp. 1575–6, Appendix P, Part II, Report of the Chief of Engineers, 1890.

One hundred and ninety-seven readings in all were obtained during the period embraced between January 21, 1890, and June 3, 1891.

Grouping the readings made when the conditions were most similar and choosing the maximum reading in each case, Table II results.

TABLE II.—*Maximum dynamometer readings for waves of different heights.*

Height of wave just before breaking.	Dynamometer reading corresponding to pressure in pounds.	Work in foot pounds necessary to compress dynamometer springs to same extent.	Number of readings taken.
Feet.	*Per square foot.*		
2.5	260	23	12
2.75	312	33	5
3.0	413	62	20
3.5	366	48	8
4.0	516	101	20
4.5	625	104	15
5.0	731	136	16
5.5	796	159	11
6.0	831	179	7

Considering only a single well-defined wave, breaking in water of a depth equal to its height from hollow to crest, the maximum effect was found at a distance above the water surface equal to about one-tenth of the wave height, from which point it decreased to zero at a distance above the water surface equal to about three-fourths of the wave height.

All available readings taken under similar conditions, at different elevations, have been grouped, and are plotted on the accompanying sheet; the ordinates representing heights above the wave hollow, in decimals of the wave height, and the abscissæ, the corresponding dynamometer readings, expressed in decimals of the maximum reading, which is considered as unity.

The observations are too few in number to give more than an approximation to the distribution of energy in the wave.

EFFECT OF WAVES IN THE IMMEDIATE VICINITY OF THE DYNAMOMETERS.

In connection with the dynamometer readings, all marked effects of wave action within about 50 feet of the dynamometers were carefully noted, and are given in the following table, together with the maximum dynamometer reading and height of wave during the same period.

Digitized by Google

Relative value of dynamometer readings at different points between hollow and crest of wave, expressed in terms of the maximum reading.

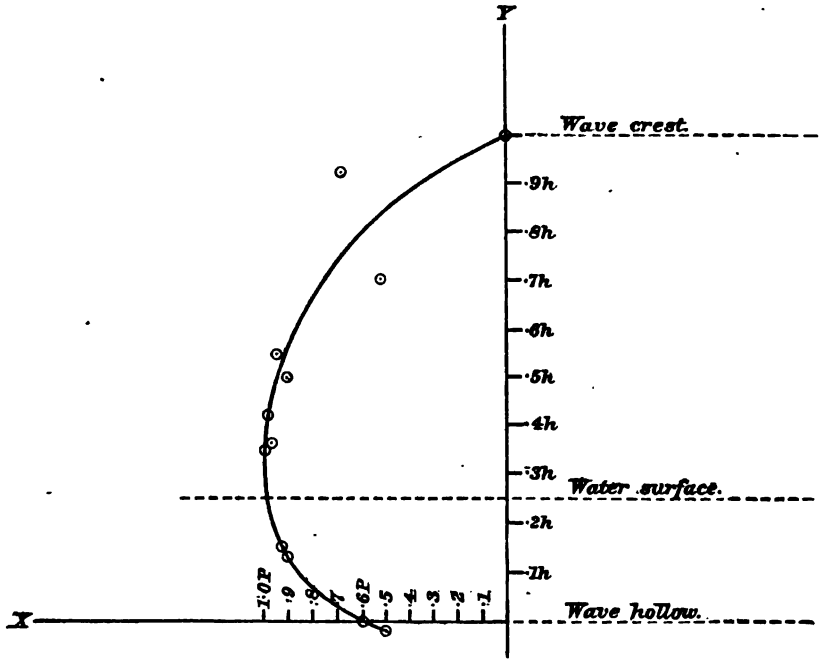


TABLE III.—*Effect of waves near dynamometers.*

Observed effects.	Maximum height of waves.	Maximum dynamometer readings in pounds pressure.
	Feet.	*Square foot.*
Block of concrete, weighing 350 pounds and resting on a flat base of 1.7 square feet area, moved several feet. Base of block, before being moved, was 1.5 feet above surface of water	3.5	428
Several cubic yards rip rap of specific gravity 2.3, piled with side slopes of 1–2, all moved several feet shorewards in 6 hours. Pieces of rip rap weighed from 40 to 167 pounds	4.0	513
Wing of rip rap, 5 feet wide on crest, with side slopes of 1–3, composed of pieces weighing 40 to 200 pounds, all moved shoreward an average distance of 28 feet in 12 hours. Ref. of crest of pile before moving 5.0 feet; after moving, 6.0 feet above mean low water	4.5	625
Block of concrete weighing 527 pounds, moved 6 feet horizontally in a single tide. Ref. of center before moving 3.8 feet, after moving 4.8 feet	4.5	533
Similar block moved 23 feet horizontally and elevated from ref. 3.5 to 4.8 feet in a single tide	4.5	509
Concrete block 2.5 by 2.5 by 5 feet, weighing 4,751 pounds, was moved 12 feet horizontally and turned over around one of its longer edges. Ref. of center of block 4.8 feet, unchanged after moving. All in one tide	4.5	593
About 30 cubic yards rip rap, weighing from 40 to 150 pounds, moved several feet shoreward. Ref. of crest of pile before moving 6.0 feet, after moving 8.0 feet	5.0	603
Concrete block 10 by 6 by 2½ feet and weighing 21,000 pounds, lifted vertically 3 inches, and there caught and held fast. Block not displaced laterally	5.5	633

Digitized by Google

REMARKS.

It is regretted that neither the funds nor the time available permitted a more extended series of dynamometer observations to be made. By using plates of various sizes on dynamometers set near together and at the same elevation, it would be easy to ascertain whether or not the indicated pressure per square foot varies with the size of the plate used. Where the wave travel is constant in direction, it would be interesting to set up dynamometers facing in different directions, in order to compare their readings with one facing the wave and having its plate vertical.

During the progress of the dynamometer observations, while many severe storms occurred, still there was not a single one of those exceptionally severe storms which visit the coast during the latter part of August or 1st of September at intervals of 4 or 5 years.

At no time during the progress of the observations was the depth of water at the dynamometers greater than 6½ feet.

Respectfully submitted.

D. D. GAILLARD,
First Lieut. of Engineers.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., June 12, 1891.

COMMERCIAL STATISTICS.

Commerce of St. Augustine Harbor, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons..	60	$1,800	60
Fruits ..... boxes..	630	1,260	25
Bananas ..... bunches..	8,115	2,400	81
Pineapples ..... number..	17,400	658	44
Grain ..... bushels..	500	425	15
Lumber, sawed ..... B. M..	3,643,335	72,866	7,300
Merchandise ..... tons..	3,500	350,000	3,500
Ship stores ..... barrels..	56	560	8
Cocoanuts ..... number..	27,455	600	40
Sea shells ..... tons..	20	805	20
Sponge ..... pounds..	1,630	161	1
Coal ..... tons..	704	4,224	704
Total	.....	435,759	11,798

Vessels.	Character.	Number of trips.	Average tonnage.	Estimated average draft of water.
				Feet.
City of St. Augustine	Steamboat	2	390	10
4 foreign	Sail	8	300	9
9 American	...do	18	202	6
20 yachts	Steam and sail ..	40	.....	6

Estimated percentage of total trade of neighborhood carried by water, 10 per cent.

There is very little depth of water over the bar, and vessels of heavy tonnage can not enter. During the year three of the foreign vessels entering for lumber were forced to complete their cargo outside the bar from lighters.

CHAS. R. HILL.

Digitized by Google

O 5.

IMPROVEMENT OF NORTHWEST ENTRANCE, KEY WEST HARBOR, FLORIDA.

The Florida Keys consist of a chain of rock and sand islands extending southwesterly from Cape Florida for nearly 200 miles. They are connected by extensive sand flats underlaid by rock, a soft oolitic limestone, from which the sand is almost entirely formed.

This chain is a barrier for all shipping from the Atlantic to the Gulf (eastern and middle) ports, and the straits between it and the West India Islands form a passage justly dreaded by mariners. This barrier is crossed by four navigable channels, one between the Dry Tortugas, at the western extremity of the chain, and Rebecca Shoals; one east of Rebecca Shoals; the third (the Boca Grande Channel) 28 miles further east, and the fourth (the northwest channel from Key West Harbor) immediately west of Key West, 85 miles east from the Dry Tortugas. It is this easterly position, combined with the good harbor of Key West at its extremity, which gives this channel its importance. It is used by vessels en route between the Atlantic and Gulf ports, which do not draw more than 10.5 feet of water, the depth available on the bar which now obstructs its northern end. An estimated average daily tonnage of 2,500 tons passes through it. In rough weather the available depth is still more reduced, and vessels of more than 8 feet draft are compelled to pass through one of the channels to the westward.

The necessity for the improvement of the northwest entrance was first brought to the notice of Congress in 1868, and an examination of the bar was ordered. This was made by Lieut. (now Maj.) W. R. Livermore, Corps of Engineers, under the direction of Col. J. H. Simpson, Corps of Engineers. A project was submitted for opening a dredged channel across the bar 300 feet wide, 18 feet deep at mean low water, and 9,000 feet long, at an estimated cost of $217,272.

Nothing more seems to have been done at that time.

In 1881 another examination of the harbor was ordered by Congress. This was made by Thomas L. Harrison, assistant engineer, under the direction of Capt. (now Maj.) A. N. Damrell, Corps of Engineers, as reported on page 1314, Report of the Chief of Engineers, 1882. Major Damrell submitted a project for dredging a cut 300 feet wide and 17 feet deep at mean low water at an estimated cost of $140,000. In 1882 Congress appropriated $25,000 for work under this project. With this a cut 60 feet wide and 15 feet deep at mean low water was made across the bar in 1883, but it was soon obliterated and no useful result was obtained. In 1886 an appropriation of $2,500 was made for the examination and survey of the bar. The survey was made in the fall and winter of 1886–'87. In 1888 a further appropriation of $25,000 was made for the improvement of the harbor, subject to the recommendation of a Board of Engineers. A preliminary report was submitted January 31, 1889, and further data having been obtained, in November, 1889, the Board submitted a final report recommending that the improvement of the entrance be begun by the immediate construction of a jetty along its northeastern side.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

In the act approved September 19, 1890, $40,000 were appropriated for the work. Proposals were opened after due advertisement, Novem-

Digitized by Google

ber 29, and a contract was made with Mr. R. G. Ross for delivering stone and constructing the jetty for $1.90 per cubic yard of stone in place. Work under the contract was to be started February 28 and finished July 28, 1891. Owing to the sickness of the contractor and other causes the quarrying of rock was not begun until May. The first stone was deposited in the jetty June 16. Up to the close of the month 1,160.3 cubic yards had been delivered.

The estimated cost of the jetty is $500,000.

The harbor at Key West is in the collection district of Key West, Fla., which is the nearest port of entry. Nearest light-house, Northwest Passage Light. Nearest fortis Fort Taylor, Fla.

Money statement.

July 1, 1890, balance unexpended		$17,091.63
Amount appropriated by act approved September 19, 1890		40,000.00
		57,091.63
June 30, 1891, amount expended during fiscal year		1,179.30
July 1, 1891, balance unexpended		55,912.33
July 1, 1891, outstanding liabilities	$2,555.93	
July 1, 1891, amount covered by uncompleted contracts	47,795.43	
		50,351.36
July 1, 1891, balance available		5,560.97

Amount (estimated) required for completion of existing project	460,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	460,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing material and constructing a dike at northwest channel entrance to Key West Harbor, Florida, received in response to advertisement, and opened on November 29, 1890.

No.	Name and address of bidders.	Stone per cubic yard.	Remarks.
1	Miller & Nims, Key West Fla	$9.67	
2	George J. Baer, Key West, Fla	4.12	
3	R. G. Ross, Jacksonville, Fla	1.90	Lowest bid.
4	J. H. Gardner, New Orleans, La	7.35	No sample of stone.

The estimated amount available for work under the approved project is $50,000.
Recommended that bid No. 3 be accepted.

Digitized by Google

COMMERCE OF KEY WEST, FLORIDA, DURING THE YEAR ENDING DECEMBER 31, 1891.

[Compiled by the Board of Trade, Key West, Fla.]

Domestic imports.

Articles.	Quantity.	Estimated value.
Fish, salted ..... tons..	25	$4,000
Lumber, rough (logs) ..... feet..	4,000,000	80,000
Lumber, sawed ..... board measure..	1,000,000	30,000
Merchandise ..... tons..	55,000	5,500,000
Vegetables ..... barrels..	25,000	100,000
Live stock ..... head..	15,500	210,600
Laths ..... number..	2,000,000	9,500
Shingles ..... do....	3,000,000	12,000
Ice ..... tons..	5,000	50,000
Total	.....	5,996,100

Foreign imports.

Vegetables and fruits ..... barrels..	50,000	125,000
Leaf tobacco ..... bales..	30,000	3,500,000
Wines ..... gallons..	80,000	60,000
Gin and other liquors ..... cases..	6,000	60,000
Total	.....	3,745,000

Domestic exports.

Cigars ..... number..	125,000,000	7,000,000
Sponges ..... pounds..	400,000	1,000,000
Pineapples ..... dozens..	300,000	300,000
Vegetables ..... crates..	100,000	100,000
Green turtle ..... pounds..	100,000	10,000
Fresh fish ..... do....	400,000	40,000
Salt fish ..... do....	50,000	4,000
Hides ..... number..	12,000	15,000
Total	.....	8,369,000

Report of Mr. John F. Hoar, collector of customs, Key West, Fla., during the year ending December 31, 1890.

	Entered.	Cleared.
Foreign—		
Steam vessels	175	200
Sailing vessels	125	115
Coastwise—		
Steam vessels	155	138
Sailing vessels	75	55
Total	530	508

Vessels (arrived and departed) not required to enter at custom-house	300
Vessels engaged in fish and turtle catching	200
Alien passengers arrived (immigrants)	3,808
All others from foreign ports	8,844
Passengers to foreign ports	9,536
Total number of passengers arrived and departed	22,188

The foregoing is a statement of the traffic to and from Key West, and does not take into consideration the amount of business which passes through the port. The Mallory Steamship Line, the Plant Steamship Company, and the Morgan Steamship

Digitized by Google

Line, have steamships which arrive in the port of Key West ten times a week, and the amount of traffic as given above represents only about 10 per centum of the business which these lines do with their terminal points. The Morgan steamships and the Plant steamships use the northwest passage exclusively; but, owing to the shoalness of the water on the bar, these companies can not build such steamships as the necessities of the business require.

The Mallory steamships which trade with Key West ply between New York and Galveston, and if there was sufficient water on the bar, would use the northwest passage in going to and from the latter port.

In addition to the trade between Key West and other ports being benefited by the deepening of the northwest passage, it would open a water way between all Gulf and Atlantic ports, which would save to the commerce of the world, plying between the Gulf and Atlantic, not only an actual distance of 75 miles each way, but would avoid the risk consequent to going around the Tortugas. The value of this saving is incalculable, and benefits the commerce of the world a hundred fold more than the great benefit it would be to Key West.

Its benefits, and the necessity for this work, are international, and not local.

Respectfully,

JEFFN. B. BROWN,
R. W. COUTHWICK,
JOHN JAY PHILBRICK,
Committee of Board of Trade, Key West, Fla.

O 6.

IMPROVEMENT OF CALOOSAHATCHEE RIVER, FLORIDA.

The Caloosahatchee River rises in the saw-grass region west of Lake Okeechobee and flows west into San Carlos Bay. Between the mouth and Fort Thompson, 22 miles west of Lake Okeechobee, the river banks are generally high, and the country bordering the river is covered with a dense growth of large trees, principally pines, palmettos, and oaks. East of Fort Thompson the low saw-grass region begins. The entire river valley as far down as Alva, about 20 miles by river below Fort Thompson, is more or less subject to overflow by the water coming from the Okeechobee Basin. For 21 miles from its mouth the river is broad and has a channel depth of from 6 to 20 feet, with the characteristics of an estuary. This portion of the river is obstructed by oyster bars. Great beds of snags obstructed the upper river. From Alva down the country is being settled for the culture of sugar-cane, pineapples, cocoanuts, oranges, limes, and lemons. Fine cattle ranges exist along the upper river.

Fort Myers, a depot for supplies during the Seminole war, is a thriving town 17 miles from the mouth.

Under the laws of the State of Florida, the Atlantic and Gulf Coast Canal and Okeechobee Land Company is engaged in draining the Okeechobee Basin, having authority from the State to cut canals and use the natural water ways for that purpose. A canal with a minimum cross section of 22 feet by 5 feet has been opened from Lake Okeechobee to the head waters of the Caloosahatchee River, and through them as far as the western end of Lake Flirt. A rocky ledge at Fort Thompson has been removed and four cut-offs have been made across the worst bends below Fort Thompson. These works were not intended for the benefit of navigation, but they have incidentally opened a water route about 300 miles long from the Gulf of Mexico to the interior of Florida, via San Carlos Bay, the Caloosahatchee River, Lake Okeechobee, the Kissimmee River, and Lakes Kissimmee, Cypress, and Tohopekaliga. Steamers now pass over the route at irregular intervals.

Digitized by Google

An examination of the river, with a view to its improvement, was made in March and April, 1879. A report thereon, dated August 27, 1879, with a plan of improvement, is printed as Appendix J 17, Report of the Chief of Engineers for 1879.

The project adopted in 1882 called for deepening the channel, by dredging, from the mouth to Fort Myers, so as to give a depth of 7 feet at mean low water for a width of 100 feet. In 1886 and 1888 this project was modified so as to include the improvement of the upper river as far as Fort Thompson, by the removal of snags and overhanging trees, and by deepening the channel near Beautiful Islands.

OPERATIONS PRIOR TO JUNE 30, 1890.

Operations were carried on under four appropriations made in acts of 1882, 1884, 1886, and 1888, aggregating $24,000. In 1885 the 7-foot channel through the lower river was reported completed. In 1886–'87 the operations were confined to clearing snags and overhanging trees from the river between Forts Denaud and Thompson, and in making an instrumental survey of the entire river. This survey showed the existence of a practicable channel 6 feet deep and at least 100 feet wide from the mouth to Fort Myers. It also showed that excepting near the Beautiful Islands the channel had sufficient depth and width to permit boats of 4 feet draft to ascend the river as high as Fort Thompson. The upper river was, however, badly obstructed by snags and overhanging trees, only a short reach 4½ miles long having been cleared by the work during May and June, 1887.

In February, 1890, the work of improvement was resumed by the United States snag boat *Suwanee*. A cut 35 feet wide, 400 feet long, and 5 feet deep was made through the Beautiful Island Shoals and protected by a pile training wall. The worst snags and overhanging trees were also removed as far as Fort Thompson.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1891.

The work of building the training wall and dredging at the Beautiful Island Shoal by the snag boat *Suwanee* was continued in the same manner as described in the last Annual Report (see pp. 1597–1599, Report of the Chief of Engineers, 1890). Forty cords of brush in fascines, 167.5 cubic yards of stone, and 135.5 cubic yards of oyster shells were placed in the dike. These were covered for about half the length of the dike with sand and mud to a height of 1 foot above mean low water. Fifty-two hundred and twenty-five cubic yards of sand and mud were dredged from the cut.

On August 5 the boat again proceeded up the river and continued the removal of obstructions. Twenty-eight large and 8 small snags and 42 overhanging trees were removed from the channel. The appropriation being nearly exhausted, the boat returned to Fort Myers on August 16 and was temporarily laid up, receiving some minor repairs. The appropriation of $3,600 made by act of September 19, 1890, becoming available, work was resumed October 13. The boat proceeded up the river to complete the removal of obstructions as far as Fort Thompson, which being done it returned to Fort Myers December 20, having removed 220 large and 72 small snags, 1,682 large and 73 small overhanging trees, 14 stumps, and 18.5 cubic yards of rock. After some slight repairs it proceeded to dredge and mark the channel through the oyster bars near the mouth of the river. Fifteen hundred and twenty and

Digitized by Google

seven-tenths cubic yards were removed, making a cut 450 feet long, 90 feet wide, and 6 feet deep at mean low water, most of it being through solid oyster beds in which the hydraulic dredging apparatus worked as successfully as it had in the sand and mud shoal at Beautiful Island. Twenty channel stakes, consisting of palmetto piles with targets properly painted, were placed to mark the channel through the oyster bars. On January 26 work was resumed at Beautiful Island Shoal and continued there until February 14. Ninety-two brush fascines were made and deposited at the foot of the dike, and 2,298.6 cubic yards of sand and mud were dredged from the cut, a large part of which was deposited on the dike.

After making the necessary preparations and repairs the boat, with the scow in tow, left Fort Myers February 19 en route for Tampa for refitting. On the 22d, while lying off Egmont in a gale, the scow was swamped and some materials lost from her deck. The snag boat was able to run under shelter. She arrived at Tampa February 28. The scow was recovered and brought in later.

Itemized statement of cost of work.

Dredging 9,044 cubic yards silt and sand, at 19 cents	$1,718.36
Placing 31 channel stakes, at $7.18	222.58
Removing 248 large snags from channel, at $1.41	349.68
Removing 80 small snags from channel, at 62 cents	49.60
Removing 1,724 large overhanging trees, at 84 cents	1,448.16
Removing 73 small overhanging trees (under 8 inches in diameter), at 32 cents	23.36
Removing 14 stumps, at 65 cents	9.10
Removing 18.5 cubic yards rock, at $1.38	25.53
Building 615 linear feet training wall, at $2.15	1,322.25
Total	5,168.62

This includes all expenses on this work for the last fiscal year, viz, office and traveling expenses, repairs, cost of carrying plant to Tampa, and the cost of a portion of the material lost off Egmont.

The work was in local charge of Mr. J. W. Sackett, assistant engineer, and Mr. Otto Bie, master of the snag boat.

All of the work of improvement contemplated has been completed, though it is believed that the dike at Beautiful Islands is not long enough to afford complete protection to the dredged cut at that shoal.

The river can be kept clear at an annual expenditure of $1,000.

Caloosahatchee River is in the collection district of Key West, which is the nearest port of entry; nearest light-house is Sanibel Island Light, and the nearest fort is Fort Taylor.

Money statement.

July 1, 1890, balance unexpended	$3,815.47
Amount appropriated by act approved September 19, 1890	3,600.00
	7,445.47
June 30, 1891, amount expended during fiscal year	7,298.86
July 1, 1891, balance unexpended	146.61
July 1, 1891, outstanding liabilities	125.00
July 1, 1891, balance available	21.61
Amount (estimated) required for maintenance of existing project	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Digitized by Google

COMMERCIAL STATISTICS.

Commerce of Caloosahatchee River, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons..	10	$250.00	10
Fish and oysters ..... barrels..	1,500	7,500.00	150
Fruits ..... boxes..	4,515	4,740.00	182
Grain ..... bushels..	13,380	15,381.25	400
Hides ..... number..	40,200	20,100.00	201
Honey, sirup, etc ..... gallons..	2,800	1,500.00	15
Lumber:			
Rough (logs) ..... feet B. M..	1,000,000	6,000.00	10,000
Sawed ..... do....	800,000	16,000.00	1,600
Merchandise ..... tons..	6,000	300,000.00	6,000
Vegetables ..... boxes..	800	1,000.00	32
Cattle ..... number..	6,800	74,800.00	1,020
Pork (dressed) ..... pounds..	35,000	1,750.00	18
Total	.....	448,971.25	19,628

Vessels.	Character.	Number.	Average tonnage.	Average draft of water.
				Feet.
Steamboats	.....	5	32	4
Spongers, etc	Sail	103	2 to 20	3
Yachts	Sail and steam ..	25	.....	4 to 6

Passengers, 3,000. Revenue derived from same, $15,000.
Estimated percentage of total trade of neighborhood carried by water, all.

CHAS. R. HILL.

O 7.

IMPROVEMENT OF CHANNEL OF CHARLOTTE HARBOR AND PEASE CREEK, FLORIDA.

Charlotte Harbor lies 74 miles south of Tampa Bay and offers the most southern deep-water harbor on the west coast of Florida. It is the northern division of the broad expanse of generally shallow water included between Gasparilla, La Costa, Captiva, and Sanibel Islands and the mainland, and of which San Carlos Bay forms the southern division. A projection from the mainland, ending in Cape Haze, gives Charlotte Harbor an angular shape, with arms of nearly equal length, starting from the Gulf and running nearly east and then north. The width of the bay is about 5½ miles. The total length along the middle line is 22 miles. The total area is 111 square miles. The general depth is from 5 to 15 feet, with deeper water in places along the middle line. The entrance, Boca Grande Pass, is straight and stable in position and depth, with a least channel depth of 19 feet at mean low water. Within the entrance there is an anchorage having an area of 580 acres and a mean low-water depth of 18 feet and over. Between this anchorage and Pease Creek entrance, at the northeastern extremity of the bay, there is an available channel depth of 15 feet at mean low water, excepting on the shoals south of Cape Haze, where the available channel depth is only 9 feet. Pease Creek is described on page 1600, vol. 2, Report of the Chief of Engineers, 1890. The portion included in the improvement of Charlotte Harbor extends from the entrance to the

Digitized by Google

wharves at Punta Gorda, a distance of 1¾ miles. Pease Creek is here quite broad and is really an estuary. It has an available channel depth of 10 feet. The tidal range of the bay and creek varies from 1.9 feet at Gasparilla Island to 1.6 feet at Punta Gorda, but it is subject to great variations, according to the strength and direction of the wind.

An appropriation of $35,000 was made in the act approved September 19, 1890, for "improving, dredging, and deepening the channel of Charlotte Harbor and Pease Creek, Florida, to the pier at Punta Gorda, the terminus of the Florida Southern Railroad."

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

A survey of the bar at the entrance and those portions of the bay and creek within the limits named in the bill which have an available depth less than 15 feet at mean low water was made in November and December, 1890, and January, 1891, by a party under the charge of Mr. J. H. Bacon, assistant engineer. A copy of his report is appended. It was found that the greatest advantage to the commercial interests of the harbor could be given with the appropriation available by making a cut across all of the shoals 12 feet deep, with a least width of 60 feet, and plainly marked.

Proposals were opened after due advertisement, and a contract was made with the Alabama Dredging and Jetty Company to dredge and mark the cuts, for 25 cents per cubic yard. This was approved by the Chief of Engineers June 11, 1891. Work will be begun as soon as the contractor has completed the cut at the entrance of Old Tampa Bay, Florida. An examination and report on the harbor were also made as directed in the act. The report is printed with those of the other examinations and surveys.

FUTURE OPERATIONS.

The estimated cost of forming a channel 200 feet wide and 12 feet deep at mean low water from the Boca Grande entrance to the wharf at Punta Gorda is $127,555; for a channel 200 feet wide and 15 feet deep it is $468,000.

The estimated cost of a channel 300 feet wide and 23 feet deep from the Gulf of Mexico to the deep anchorage just within Boca Grande entrance is $35,000.

Phosphate deposits are found in enormous quantities throughout the Pease Creek Valley, and the shipment of phosphates forms the principal commercial interest of the harbor; 13,500 tons were shipped during the year 1890, though the business is not yet developed. This phosphate was brought by rail to the wharf at Punta Gordà and lightered from there to vessels lying in the Boca Grande anchorage. This point will be the point of shipment for phosphate from the Caloosahatchee River also, in all probability. Its importance is evident. Other shipments to and from Charlotte Harbor included grain, fish and oysters, lumber, and general merchandise. An extension of the railroad to the Boca Grande entrance is projected.

Charlotte Harbor is in the collection district of Key West, and Tampa is the nearest port of entry; nearest light-house is Gasparilla Light, and the nearest fort is Fort Taylor.

The following papers accompany this report, viz:

Report of Mr. J. H. Bacon, assistant engineer,
Map of Charlotte Harbor.

Digitized by Google

Money statement.

Amount appropriated by act approved September 19, 1890		$35,000.00
June 30, 1891, amount expended during fiscal year		2,886.44
July 1, 1891, balance unexpended		32,113.56
July 1, 1891, outstanding liabilities	$20.06	
July 1, amount covered by uncompleted contracts	29,500.00	
		29,520.06
July 1, 1891, balance available		2,593.50

REPORT OF MR. J. H. BACON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., May 6, 1891.

CAPTAIN: I have the honor to submit the following report on the survey of Charlotte Harbor, Florida:

The surveying party, consisting of myself, Messrs. A. C. Harper and George Berry, transitmen, and K. R. Streatfield and C. M. Brown, recorders, established camp on Cape Haze on November 18, 1890. Actual field work was begun on November 21. The field work of the survey consisted in:

I. BASE LINES.

A base line 16,029 feet in length was carefully measured and checked along the east shore of the harbor opposite Cape Haze. This base line was measured with a 100-foot brass tape in water averaging 3 feet deep. The tape was carried by five men, one at each end, while the other three were stationed at equal intervals to take up the sag. The second measurement of this base differed from the first by 0.43 foot.

Another base line 3,931 feet in length was measured (and checked) along the railroad track on Long Wharf at Punta Gorda.

II. TRIANGULATIONS.

From these two base lines two systems of triangulations were developed, one for the lower bay, extending from the east shore to Gasparilla Island; the other for the upper bay, extending from Long Wharf, Punta Gorda, to the lower back beacon opposite the mouth of the Myakka River.

Angles were repeated carefully with the transit and adjusted. Permanent signals were erected at each station.

III. SOUNDINGS.

All soundings were made from the naphtha launch *Myakka* by means of a sounding pole 20 feet long, graduated to feet and tenths from each end. By using each end of this pole alternately it was possible to run the launch at full speed (about 6 miles per hour) and obtain soundings at an average interval of 50 feet. The sounding lines in the lower bay radiate from Charlotte Harbor light-house and from Station N. The launch was kept on line by signals from the transit station. Soundings were located at intervals of 1 minute by means of a transit and sextant. The location of the soundings was plotted in the field during the progress of the work.

IV. BORINGS.

Borings were made along the proposed lines of dredging across the shoals below the Long Wharf at Punta Gorda and opposite Cape Haze. The material found in the first-mentioned locality is a very soft mud; that in the second is a coarse shell sand. Borings were made in each case to a depth of 20 feet below mean low water. No rock whatever was found.

The material forming these shoals can be most economically removed by means of pump dredges.

V. CURRENT OBSERVATIONS.

Current observations were made in the upper and lower bays by means of loaded rods. In each case the direction of the current is parallel, or nearly so, with the proposed cuts. The average velocity of the current is from 1 to 1½ miles per hour.

Digitized by Google

VI. TIDES.

The rise and fall of the tide was observed daily at Long Wharf, Punta Gorda, at Charlotte Harbor light-house, opposite Cape Haze, and at Gasparilla light-house, on Gasparilla Island. The mean tidal ranges at these points are 1.6 feet, 1.7 feet, and 1.9 feet, respectively. A mean low water was established from these observations. As is usual, however, in harbors on the Gulf of Mexico, the tides are greatly influenced by the force and direction of the winds. The lowest tide observed fell 1.5 feet below mean low water, and the highest rose 0.5 feet above mean high water.

VII. ENTRANCE TO BOCA GRANDE.

Soundings were also made across the entrance to Boca Grande. The material here consists of fine sand. Boca Grande is flanked on either side by extensive shoals, extending about 3 miles out from the shore and acting as jetties. An available depth of 19 feet at mean low water was found on the bar. A cut of sufficient width to a depth of 24 feet would probably be permanent.

The survey was finished on January 17, 1891, and the party proceeded to Tampa, Fla. The progress of the survey was greatly delayed by stormy weather. The prevailing winds during the months of December and January are from NE. and NW. These winds frequently attain a high velocity, and form waves from 3 to 4 feet in height throughout the entire bay. Dredging operations can be carried on to the best advantage from April to November.

Maps of the scale of $\frac{1}{10000}$ and $\frac{1}{80000}$ are submitted with this report.

ESTIMATES FOR DREDGING.

No. 1.—*Estimate for expending the present appropriation of $35,000 for making a channel 300 feet wide and 22 feet deep across the bar of Boca Grande.*

Removing 98,333 cubic yards, at 30 cents	$29,500
Survey of Charlotte Harbor (expended)	2,000
Engineering and contingencies, 10 per cent	3,500
Total	35,000

No. 2.—*Estimate for expending the present appropriation of $35,000 for making a channel 50 feet wide and 12 feet deep from Long Wharf, Punta Gorda, to Boca Grande.*

Removing 97,800 cubic yards, at 30 cents	$29,340
Survey of Charlotte Harbor (expended)	2,000
Eight clusters of creosoted (3 piles each), at $20	160
Engineering and contingencies, 10 per cent	3,500
Total	35,000

No. 3.—*Estimate for forming a channel 200 feet wide and 15 feet deep from Long Wharf, Punta Gorda, to Boca Grande.*

Cut.	Reach.	Character of bottom.	Cubic yards.
1	a	Mud	235,000
1	b	do	185,000
1	c	do	133,000
2	a	Shell sand	128,000
2	b	do	170,000
2	c	do	220,000
2	d	do	183,000
2	e	do	61,000
3	a	do	102,000
Total			1,417,000

Excavation, 1,417,000 cubic yards, at 30 cents	$425,100
Eighteen clusters of 3 creosoted piles, each at $20	360
Engineering and contingencies, 10 per cent	42,540
Total	468,000

Digitized by Google

No. 4.—*Estimate for forming a channel 200 feet wide and 12 feet deep from Long Wharf, Punta Gorda, to Boca Grande.*

Cut.	Reach.	Character of bottom.	Cubic yards.
1	a	Mud	117,000
1	b	do	74,000
2	b	Shell sand	102,000
2	d	do	93,000
Total			386,000

Excavation, 386,000 yards, at 30 cents	$115,800
Eight clusters of 3 creosoted piles, each at $20	160
Engineering and contingencies, 10 per cent	11,596
Total	127,556

No. 5.—*Estimate for forming a channel 300 feet wide and 23 feet deep across the bar of Boca Grande.*

Removing 105,000 cubic yards, at 30 cents	$31,500
Engineering and contingencies, 10 per cent	3,150
Total	34,650

NOTE.—In the above estimates 25 per cent. for increase of bulk and 1 foot extra cutting has been allowed.

Very respectfully, your obedient servant,

J. H. BACON,
Assistant Engineer.

W. M. BLACK,
Captain, Corps of Engineers.

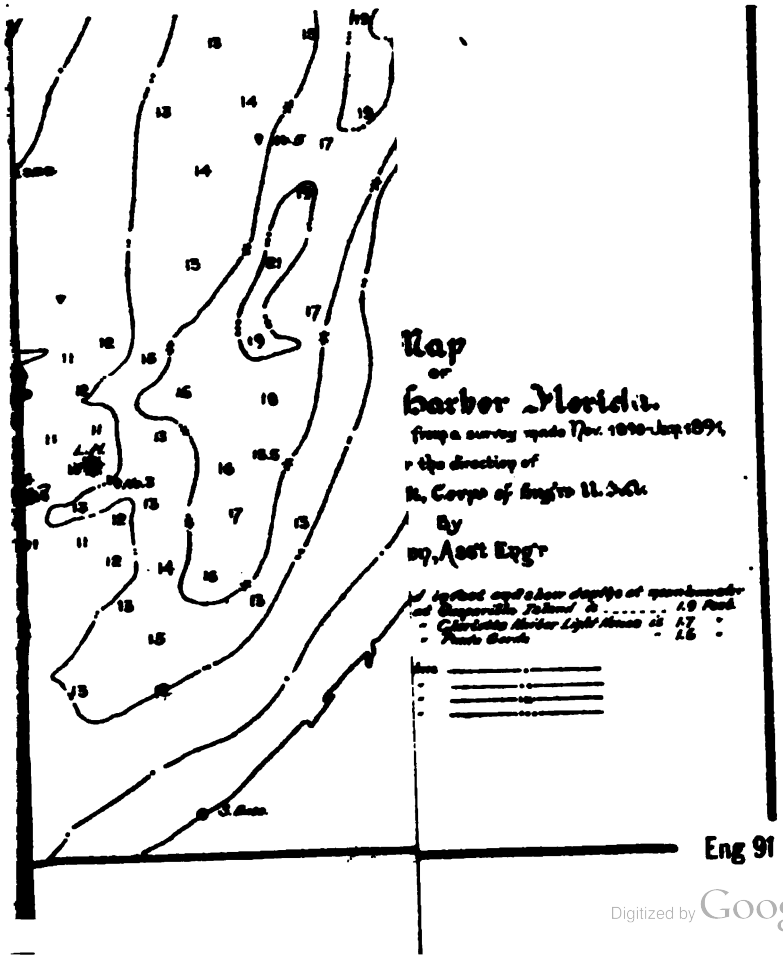
COMMERCIAL STATISTICS.

Commerce of Charlotte Harbor and Pease Creek, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fish and oysters ..... barrels	11,840	$41,270	1,616
Fruits ..... boxes	10,094	12,617	404
Grain ..... bushels	93,600	82,544	1,872
Hides ..... number	2,000	1,500	12
Honey, sirup, etc ..... gallons	8,000	4,500	15
Lumber—			
Rough ..... feet	1,000,000	6,000	1,800
Sawed ..... B. M.	950,000	19,000	1,200
Merchandise ..... tons	1,460	175,000	1,460
Ship stores	.....	80	5
Cattle ..... number	2,389	26,279	358
Breadstuffs ..... barrels	12,156	68,076	1,215
Shingles ..... number	500,000	1,500	200
Phosphate rock ..... tons	13,480	90,990	13,480
Total	.....	529,356	23,631

Vessels.	Character	Number.	Average tonnage.	Average draft of water.
				Feet.
Foreign	Steamers	3	2,875	18
	do	2	14	4½
Coasters	Sail	70	900	10
Yachts	Steam and sail	10	15	6

Digitized by Google



Digitized by Google

Digitized by Google

Passengers, 5,500; revenue received from same, $27,500.

Estimated percentage of total trade of neighborhood carried by water, 40 per cent. Probable increase of trade were the improvement completed, 500 per cent.

REMARKS.—Punta Gorda, on Charlotte Harbor, is the port of shipment for all the phosphates mined along the Pease River and the line of the Florida Southern Railroad.

Many mills are now in active operation through this section and the future of the enterprise depends entirely on the facilities provided for water transportation. At present there is not a sufficient depth of water in the harbor to permit of the phosphates being handled to any great advantage. Immediate improvement is a necessity.

The estimated number of passengers carried between Punta Gorda, Fort Myers, and intermediate points during the year is 3,000.

CHAS. R. HILL.

O 8.

IMPROVEMENT OF SARASOTA BAY, FLORIDA.

Sarasota Bay extends south from Tampa Bay along the west coast of Florida. Its length between Tampa Bay and Casey Pass is 34 miles. It is separated from the Gulf of Mexico by a chain of low sandy keys, which vary in width from 300 feet to 1 mile.

There are five navigable entrances to the bay, one from Tampa Bay and four from the Gulf of Mexico. These are named in their order from north to south, Palma Sola or Sarasota Pass, Longboat Inlet, Big Sarasota Pass, Little Sarasota Pass, and Casey Pass, and have available channel depths of 4.3 feet, 5 feet, 7 feet, 5.3 feet, and 3.5 feet, respectively. Between Big and Little Sarasota passes the bay is divided into two parts, named Big Sarasota Bay and Little Sarasota Bay, respectively, by a cluster of small islands covered with mangrove bushes and known as the "Mangroves." The channels between these islands are narrow and crooked and a places are bare at low water.

Sarasota Bay is bordered by lands well suited for raising fruits and vegetables. The country roads are few and poor. The nearest railroads are at Port Tampa and St. Petersburg, on the north side of Tampa Bay, where are also steamship lines to Gulf ports and Cuba.

The products of this country include palmetto, agave, and banana fibers, honey, sugar, sirup, oranges, lemons, limes, bananas, pineapples, vegetables, lumber, fish, oysters, and cattle. Owing to the absence of regular and economical facilities for transportation, but few of these products are exported. Trade is limited to the actual necessities of the population.

A navigable channel with a minimum depth of 5 feet extends throughout the length of Big Sarasota Bay excepting in two reaches, Palma Sola Pass and Long Bar, which have a total length of 5,400 feet. In these reaches the available depth was 4.3 and 3.5 feet, respectively; the tidal range in the bay is 1.5 feet.

An examination and survey of the bay was made in 1889. The report thereon, with the project for improvement, is printed on page 1617, volume II, of the Report of the Chief of Engineers for 1890. An appropriation of $5,000 was made in the act approved September 19, 1890, for "improving Sarasota Bay from Tampa Bay to Sarasota, Fla."

The approved project calls for the formation of a channel 5 feet deep at mean low water, and 100 feet wide. The estimated cost is $10,000.

On account of the small amount available and the slight depth of water, it was considered most economical and advantageous to do this work with the U. S. snag and dredge boat *Suwanee*, as soon as her serv-

Digitized by Google

ices might be available. As she was needed for the work in the Caloosahatchee and Suwanee Rivers no work was possible in Sarasota Bay during the fiscal year. Work will probably be started at an early date.

Sarasota Bay is in the collection district of Tampa, which is the nearest port of entry. Nearest light-house is Egmont Key Light. Nearest fort is Fort Taylor.

Money statement.

Amount appropriated by act approved September 19, 1890	$5,000.00
June 30, 1891, amount expended during fiscal year	273.00
July 1, 1891, balance unexpended	4,727.00
July 1, 1891, outstanding liabilities	255.00
July 1, 1891, balance available	4,472.00
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Commerce of Sarasota Bay, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons..	50	$1,500.00	50
Fish and oysters ..... barrels..	2,000	12,000.00	200
Fruits ..... boxes..	50,000	75,000.00	2,000
Grain ..... bushels..	5,000	3,000.00	125
Hides ..... number..	2,000	800.00	75
Honey, sirup, etc ..... gallons..	4,000	2,000.00	12
Lumber, sawed ..... B. M..	20,000	300.00	40
Merchandise ..... tons..	500	25,000.00	500
Vegetables ..... boxes..	5,000	5,000.00	200
Total		124,600.00	3,202

Vessels.	Character.	Number.	Average tonnage.	Average draft of water.
				Feet.
Coasters	Sail	*50	10	4

*No boats make regular tripe to this bay. Small trading schooners are running in from and to Tampa at irregular intervals.

Passengers, number 1,000, amount received from same (estimated), $5,000.

Estimated percentage of total trade of neighborhood carried by water, all.

Probable increase of trade were the improvement completed incalculable.

Remarks.—Owing to the imperfect channel, there is no regular line of boats running. This tends to discourage producers and prevents the cultivation of lands which, under more favorable conditions for the marketing of their products, might be utilized for raising fruits and vegetables.

The future development of this section depends on the opening of a channel about 6 feet in depth through the greater portion of the bay, enabling steamers to collect the fruits and vegetables and carry them for reshipment at Tampa.

The phosphate industries will depend for their development on the improvement of the bay, or the construction of a railroad to Braidentown on the Manatee River.

CHAS. R. HILL.

Digitized by Google

O 9.

IMPROVEMENT OF MANATEE RIVER, FLORIDA.

Manatee River rises in the southern part of Florida and flows in a westerly direction, emptying into Tampa Bay on its southern shore. For a distance of 12 miles from its mouth it has the characteristics of an estuary. For 10 miles the settlements along its banks are almost continuous. They comprise the towns of Manatee, Hendrix, Ellenton, Palmetto, Braidentown, and Palma Sola. Oranges and vegetables are raised in large quantities. From the fine ranges along the upper river hides, wool, and sheepskins are exported. Phosphate deposits have been discovered along the river and mining operations are contemplated in the near future.

Before improvement, in the estuary the general depth of the river varied from 7 to 20 feet. At the mouth there was a long shoal with a depth of 7 feet. Between Palmetto and Manatee there was another bar covered by from 3 to 5 feet of water.

An examination of Manatee River, with a view to its improvement, was made in 1881. A report thereon, dated February 16, 1882, with plan of improvement, is printed as part of Appendix K 25, Annual Report of the Chief of Engineers for 1882.

PROJECT OF IMPROVEMENT.

The original project had for its object to form a channel 100 feet wide and 13 feet deep at mean low water, from Tampa Bay to Shaw and McNeil points, a distance of about 4 miles. The available depth before improvement was 7 feet.

Since the original project was adopted, railroad and steamship lines have been established, which make Tampa the distributing point for the neighboring portion of Florida. Accordingly, it was decided to modify the project for the improvement of Manatee River, so as to open up the entire lower river to light-draft boats which would connect with the transportation lines centering at Tampa. The project as modified, calls for the formation of a channel 100 feet wide and 8 feet deep at mean low water from Tampa Bay to Manatee. The inhabitants of the country bordering the Manatee desire the completion of the original project.

OPERATIONS PRIOR TO JUNE 30, 1890.

Work has been carried on under three appropriations, viz: $12,000 made in the act of 1882; an allotment of $11,000 from the appropriation made in the act of 1886, and $5,000 made in the act of 1888. With the appropriation a dredged cut was made across the bar at the mouth of the river. With the other appropriations a survey of the river was made (the report, with a map of the river, is printed on page 1109, Report of the Chief of Engineers for 1888) and a channel 105 wide and 8 feet deep at low water was dredged through the shoal between Manatee and Braidentown.

An appropriation of $6,000 was made in the act approved September 19, 1890, for continuing the improvement. A channel 8 feet deep already exists from Tampa Bay to Manatee. Any further deepening of this channel should be begun at the bar at the mouth. The amount available would be barely sufficient to make a very narrow cut 12 feet deep across the bar. It is doubtful if an unprotected dredged cut of

Digitized by Google

any width could be maintained there and it is quite certain that money expended on a narrow cut would give no useful results. Under these considerations it was decided to hold the money available until it might be required for clearing the existing channel, or until further appropriations should increase it to a sum which could be expended advantageously.

Manatee River is in the collection district of Tampa. Tampa is the nearest port of entry. Nearest light-house is Egmont Key Light. Nearest fort is Fort Taylor.

Money statement.

July 1, 1890, balance unexpended	$191.87
Amount appropriated by act approved September 19, 1890	6,000.00
	6,191.87
June 30, 1891, amount expended during fiscal year	73.80
July 1, 1891, balance unexpended	6,118.07
July 1, 1891, outstanding liabilities	7.75
July 1, 1891, balance available	6,110.32
Amount (estimated) required for completion of existing project	39,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Commerce of Manatee River, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons..	363	$10,890.00	363
Fish and oysters ..... barrels..	9,900	15,500.00	665
Fruits ..... boxes..	84,400	169,800.00	3,376
Grain ..... bushels..	110,800	176,600.00	1,753
Hides ..... number..	7,550	16,650.00	46
Honey, sirup, etc ..... gallons..	17,600	9,775.00	70
Lumber—			
Rough ..... feet..	490,000	2,940.00	4,900
Sawed ..... B. M..	560,000	11,200.00	1,120
Merchandise ..... tons..	3,703	200,150.00	3,703
Ship stores	.....	180.00	9
Vegetables ..... boxes..	71,675	144,300.00	2,867
Crate stuffs ..... number..	123,000	167,550.00	4,920
Hogs ..... do....	1,450	8,840.00	107
Total	.....	934,375.00	23,899

Vessels.	Character.	Number.	Average tonnage.	Average draft of water.
				Feet.
Tri-weekly	Steamers	1	350	8
Daily	....do	1	175	6
Coasters	Sail	50	40	6
Sharpies, fisheries, etc*	....do	100	5 to 20	4

* Estimated.

Passengers, number, 15,650; amount received from same (estimated), $31.300.
Estimated percentage of total trade of neighborhood carried by water, all.
Probable increase of trade were the improvement completed, incalculable.

Remarks.—There are very rich deposits of phosphate throughout this entire section. Until deep-draft vessels can enter the river from Tampa Bay nothing can be done in the way of mining and milling. Could a continuous channel 14 feet in

Digitized by Google

depth be given from Tampa Bay up Manatee River as far as Manatee, the output of phosphates and other productions would compare favorably with that of any other port in the district. A railroad is contemplated from Braidentown, on Manatee River, to Sarasota Bay. Such a road would undoubtedly divert the greater part of the water traffic of the bay to the river, which would increase the tonnage of the Manatee River fully 100 per cent.

CHAS. R. HILL.

O 10.

IMPROVEMENT OF TAMPA BAY, FLORIDA.

Tampa Bay is a large indentation in the Gulf coast of Florida, with an average width of from 6 to 7 miles, and a length, including Hillsboro and Old Tampa bays, into which its inner end is divided, of 35 miles. Across the bar and up to the point of division, a distance of 25 miles, the channel has a depth of from 20 to 38 feet.

Old Tampa Bay, the northwestern division, is about 10 miles long, with an average width of 5½ miles. Near its mouth there is a channel depth of over 20 feet of water. A depth of 10 to 12 feet extends to its head. Hillsboro Bay has an average width of 5 miles, with depth varying from 16 feet at the mouth to 8 feet near the head. Flats with low-water depths of from 1 to 5 feet, varying in width from one-quarter to 1 mile, surround the entire body of water.

Its principal tributary is the Manatee River. The principal town is Tampa, lying at the mouth of the Hillsboro River, at the head of Hillsboro Bay, but separated from the deep water of the bay by a broad flat, through which runs a narrow channel formed by the waters of Hillsboro River. Through this, before improvement, vessels drawing 8 feet of deep water were able to reach Tampa only by taking advantage of high tides. The Florida Central and Peninsular Railroad has its terminus at Tampa.

The South Florida Railway now has its terminus at Port Tampa, near the mouth of Old Tampa Bay, where it makes connection with steamship lines for Key West, Havana, Mobile, and Central American ports. Port Tampa is about 9½ miles from Tampa, with which city it is connected by the railway, and for which it is the deep-water port.

An examination of Tampa Bay, with a view to its improvement, was made in 1879. A report thereon, dated August 25, 1879, with a plan of improvement, is printed as Appendix J 18 to the report of the Chief of Engineers for 1879.

FORMER PROJECT OF IMPROVEMENT.

The improvement proposed was to deepen and widen the channel from Tampa to the bay, a distance of 5¾ miles, by dredging and rock excavation, so as to give a clear depth of 9 feet at mean low water, and a width in the river of 200 feet, and in the bay of 150 feet.

OPERATIONS PRIOR TO JUNE 30, 1888.

Work was done by contract under the following appropriations:

By act approved—	
June 14, 1880	$10,000
March 3, 1881	10,000
By act passed August 2, 1882	20,000

Digitized by Google

By act approved—	
July 5, 1884	$20,000
August 5, 1886	10,000
Total	70,000

The work consisted entirely of dredging and rock excavation, and extended over a length of 8,200 feet, making a cut varying in width from 200 feet in the river to 60 feet in the bay. In the bay it has been partly filled by cross tidal currents. On June 30, 1887, it had a depth along the center line of from 8.3 to 9 feet. The depth in the bay beyond the outer extremity of the cut is 7 feet. The estimated cost of completing the dredged channel called for by this project is $63,000.

MODIFIED PROJECT.

In 1888 the project was changed. It now contemplates the formation and maintenance of a channel 8 feet deep in Hillsboro Bay and Hillsboro River to the city of Tampa, and the formation of a channel 200 feet wide and 20 feet deep at mean low water from the outer bar to Port Tampa.

The estimated cost of the revised project was $60,000. Two appropriations have been made, in the acts of 1888 and 1890, aggregating $50,000.

OPERATIONS PRIOR TO JUNE 30, 1890.

Operations were carried on under a contract with Mr. D. G. Ambler, dated March 22, 1889, but with many delays. Up to June 30, 1890, only 14,688 cubic yards had been removed, starting a cut through the bulkhead at the entrance to Old Tampa Bay.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1891.

Dredging was continued under the contract with Mr. Ambler from September 14 until March 28, when the contract was completed. During the entire contract 63,459 cubic yards of sand, shell, and silt were removed from the lower bulkhead (that at the entrance to Old Tampa Bay) and 12,058 cubic yards from the upper bulkhead (near Port Tampa). When work was suspended the cut at the entrance had a mean low-water depth of 20 feet and width of 115 feet for one-half its length and of 100 feet for the remaining distance, with an additional width of 75 feet the entire length, having a mean low water depth of 16 feet. The upper cut was 150 feet wide with a mid-channel depth of 19.7 feet. The tidal range is 1.5 feet.

A resurvey of the Hillsboro Bay channel was made in January, 1891, by Mr. J. H. Bacon, assistant engineer. His estimate of the cost of completing an 8-foot channel 150 feet wide to Tampa is $33,000.

On May 11, 1891, proposals for continuing dredging operations and marking the cuts in Old Tampa and Hillsboro bays, under the appropriation of September 19, 1890, were opened after due advertisement. A contract for the work at 25 cents per cubic yard was made with the Alabama Dredging and Jetty Company, which was approved by the Chief of Engineers, June 11, 1891.

Work in Old Tampa Bay is to be started August 1.

Tampa Bay is in the collection district of Tampa, which is the nearest port of entry. Nearest light-house is Egmont Key Light. Nearest fort is Fort Taylor.

Digitized by Google

Money statement.

July 1, 1890, balance unexpended		$21,853.45
Amount appropriated by act approved September 19, 1890		25,000.00
		46,853.45
June 30, 1891, amount expended during fiscal year		22,047.45
July 1, 1891, balance unexpended		24,806.00
July 1, 1891, outstanding liabilities	$52.75	
July 1, 1891, amount covered by uncompleted contracts	21,100.00	
		21,152.75
July 1, 1891, balance available		3,653.25
Amount (estimated) required for completion of existing project		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for improving Charlotte Harbor and Tampa Bay, Florida, received in response to advertisement and opened May 10, 1891, by Capt. W. M. Black, Corps of Engineers.

Name of bidder.	Name of work.			Remarks.
	Improving Charlotte Harbor.	Improving Old Tampa Bay.	Improving Hillsboro Bay.	
The Alabama Dredging and Jetty Company, Mobile, Ala.	*Per cub. yd.* $0.25	*Per cub. yd.* $0.25	*Per cub. yd.* $0.25	Only bidder.

Amount available for work, $50,600.
Recommended that the bid be accepted.

COMMERCIAL STATISTICS.

Commerce of Tampa Bay and Hillsboro River during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons	1,750	$52,500.00	1,750
Fish and oysters ..... barrels	10,718	42,872.00	1,608
Fruits ..... boxes	156,045	312,090.00	6,241
Bananas ..... bunches	304,250	76,062.50	6,080
Grain ..... bushels	331,754	281,990.00	8,294
Hides ..... No.	1,000	500.00	10
Lumber:			
Rough ..... feet	1,500,000	9,000.00	15,000
Sawed ..... B. M.	4,048,000	80,960.00	8,096
Merchandise ..... tons	15,615	1,171,125.00	15,615
Tobacco, bales ..... No.	8,059	2,296,815.00	100
Vegetables ..... boxes	24,191	29,029.00	1,210
Flour, grits, etc ..... bbls	71,065	355,325.00	7,107
Coal ..... tons	4,449	26,694.00	4,449
Steel rails (railroad) ..... do	7,105	248,675.00	7,105
Phosphate rock ..... do	885	6,195.00	885
Cigars ..... boxes	1,928	10,000.00	5
Total	.....	4,999,832.50	83,555

Passengers, 48,120.
Estimated percentage of total trade of neighborhood carried by water, 75 per cent.

Digitized by Google

The Plant Steamship Company contemplates building during the present year (1891) a ship canal on the north side of their long dock at Port Tampa. The canal will be 300 feet wide and about 2,500 feet long, with a 20-foot depth of water. Should further improvement increase the depth through the channel to the bar the company will dredge their canal to a similar depth.

This canal is intended to handle the increasing phosphate trade, and it is estimated that from 1,200 to 1,500 tons of phosphate can be loaded per day.

Trade with the West Indies and South America is steadily increasing.

Almost the entire tonnage of phosphate rock goes to foreign ports, chiefly to Liverpool, England. The phosphate industry at this port is attracting deep-draft foreign vessels (mostly British) of heavy tonnage. Loading these vessels to their full carrying capacity is the only way by which this trade can be handled profitably, but with the present depth of water through the cuts (21 feet, 6 inches) this can not be done.

The entire trade of the neighborhood is carried by water.

Port Tampa is the port of shipment for a large and very rich section of phosphate lands. Extensive operations in mining and milling phosphates are being carried on along the line of the South Florida Railroad and its branches, having Port Tampa for a southern terminus. The following estimate of the phosphate shipments made and to be made from Port Tampa during 1891 has been kindly furnished by Mr. J. E. Ingraham, president of the South Florida Railroad.

	Tons.
Sterling Mines	20,000
Florida Phosphate Company	25,000
Jacksonville and Pease Creek Phosphate Company	20,000
Pharr Company	10,000
Netherlands Company	6,000
Bartow Company	20,000
Adams Company	10,000
Hamburg Company	25,000
Total	136,000

Several lines of ocean steamers are now running regularly between Port Tampa and New Orleans, Mobile, Havana, Key West, New York, and intermediate points, as well as many small freight and passenger steamboats employed in the trade of the neighborhood. A line of fast ocean steamers fitted with refrigerators, for use in the South American fruit trade, is contemplated, to connect at Port Tampa with a fast freight service by rail to New York.

The following is a list of steamers, etc., arriving and departing during the year ending December 31, 1890:

Name and character.	No. of trips.	Average tonnage.	Average draft.
Steamship:			*Feet.*
Olivette	40	1,611	13
Mascotte	60	884	11
Juniata	50	1,200	10
Cumberland	20	125	6½
Hutchinson	24	1,200	10
Aransas	20	900	10
Lizzie Henderson	15	250	7
Naugatuck	75	300	7
Margaret	75	250	7
Iola	50	150	6
Kissimmee	200	188	5½
Sadie	50	50	5
Saragossa	1	1,200	18
10 small steamers	25	600	4½ to 5
18 foreign steamers	1	800	12
24 foreign schooners	1	600	9
100 coastwise schooners, sloops, etc	1	4	2 to 3½
45 sharpies, launches, pleasure boats, etc	6	6	2 to 6

CHAS. R. HILL.

Digitized by Google

O 11.

IMPROVEMENT OF WITHLACOOCHEE RIVER, FLORIDA.

The Withlacoochee River rises not far from Kissimmee, south of the center of the peninsula of Florida, and flowing north and west reaches the Gulf of Mexico at a point about 20 miles southeast from Cedar Keys. It has a total length of 120 miles. Pemberton Ferry, made the present head of navigation by the railroad trestle bridge of the South Florida Railroad, is 77 miles from the mouth. The roads of the Florida Railway and Navigation Company and of the Silver Springs, Ocala and Gulf Railroad Company touch the river at Panasoffkee and Dunnellon, respectively 57 and 31 miles from the mouth. The country bordering the river consists mainly of fine hummock land and cypress swamps. Large quantities of fruits and vegetables are grown and the country is fast being settled. Extensive deposits of phosphates have recently been discovered along the lower river.

The absence of good wagon roads and of parallel railroads greatly increases the importance of the Withlacoochee River as a means of communication and transportation.

Before improvement, this river was so badly obstructed that no regular navigation was possible, and the river was used only for rafting cedar logs, or for an occasional push boat. The obstructions consisted of ledges of limestone rock, sand bars, snags, and overhanging trees. At certain points the river expands in broad marshy lakes and cypress swamps, in which there is no clearly-defined channel. The general depth was from 1 to 7.5 feet, with a width of from 75 to 180 feet.

Operations for the improvement of this river have been carried on in accordance with the project submitted to the Chief of Engineers in 1879 by the officer then in charge, and published as part of Appendix K 18 to the Annual Report of the Chief of Engineers for 1880.

PROJECT OF IMPROVEMENT.

The project adopted is to improve the river by the removal of snags, overhanging trees, and loose rocks, and the deepening of some of the worst shoals and a bar at the mouth of the river, so as to enable boats drawing 2 feet to navigate the river during about one-half the year from the mouth to Hays Ferry, a distance of 71 miles. In 1886 the project was modified to permit the improvement to be continued as far as Pemberton Ferry, 6 miles from Hays Ferry.

OPERATIONS PRIOR TO JUNE 30, 1890.

Work was carried on under the following appropriations:

By act approved—	
March 3, 1881	$7,500
July 5, 1884	3,000
August 5, 1886	3,000
By act passed August 11, 1888	5,000
Total	18,500

The work was done partly by hired labor and partly by contract. The entire river from the mouth to Pemberton Ferry was gone over and the worst obstructions were removed.

At the close of operations the channel called for by the project had been formed between Pemberton Ferry and Dunnellon, though there are still obstructions which must be removed before navigation is safe.

Digitized by Google

Between Dunnellon and the mouth are 2 dangerous rock ledges and many overhanging trees which require removal.

The services of the snag boat *Suwanee* not having been available, on account of her work on the Caloosahatchee and Suwanee rivers, there were no operations during the fiscal year ending June 30, 1891.

There are several lines of small steamers plying between Pemberton Ferry, Panasoffkee, and landings south of the marshy lake, south of Morrison Landing. There is no regular navigation of the river north of Morrison Landing excepting by timber rafts.

The growing commercial importance of the Withlacoochee River warrants a more extended plan of improvement, and I would renew the recommendations made in the Annual Reports for 1887 and 1888, that the project be modified so as to provide for navigation during the entire year over those portions of the river between Pemberton Ferry and Colton's Grove, and between Morrison's Landing and the mouth. The excepted reach is a broad marshy lake, through which a low-water channel could be formed and maintained only by dredging, to the detriment of the river above.

The estimated cost of this extension of the project is $22,400. Once formed the channel can be maintained at an annual expenditure not exceeding $800. In these rivers a channel is only kept open by constant use. An unused channel is soon rendered permanently unfit for navigation without expensive work by the dams and bars formed by the rapid accumulation of driftwood and water weeds, so that a complete opening of the river for navigation throughout the year is in the interest of economy, apart from the commercial advantages gained.

Withlacoochee River is in the collection district of St. Marks, Fla., of which Cedar Keys is the nearest port of entry. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion, Fla.

Money statement.

July 1, 1890, balance unexpended	$1,729.79
Amount appropriated by act approved September 19, 1890	5,400.00
	7,129.79
June 30, 1891, amount expended during fiscal year	1,089.62
July 1, 1891, balance unexpended	6,040.17
July 1, 1891, outstanding liabilities	36.05
July 1, 1881, balance available	6,004.12

COMMERCIAL STATISTICS.

Commerce of Withlacoochee River, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Fertilizers ..... tons	350	$12,250.00	350
Fruits ..... boxes	28,735	57,470.00	1,149
Grain ..... bushels	15,171	12,895.00	525
Hides ..... number	119	59.50	1
Honey, sirup, etc ..... gallons	2,000	1,000.00	12
Lumber:			
Logs ..... feet	5,000,000	30,000.00	50,000
Sawed ..... B. M.	98,000	1,960.00	196
Merchandise ..... tons	1,150	57,500.00	1,150
Vegetables ..... boxes	2,750	6,890.00	138
Breadstuffs ..... barrels	1,110	5,550.00	120
Phosphate ..... tons	25	187.50	25
Total	.....	185,762.00	53,666

Digitized by Google

Commerce of Withlacoochee River, Florida, etc.—Continued.

Vessels.	Average tonnage.	Average draft of water.
Steamboat:		*Inches.*
Reindeer	11	18
Suwanee	58	24
Sam. Pyles	62	20

Passengers, number 600; amount received from same, $150.

Estimated percentage of total trade of neighborhood carried by water, 30 per cent.

Probable increase of trade were the improvement completed, 200 per cent.

Remarks.—(Dunnellon.) There is no business on the lower river from Dunnellon to the mouth, except log rafting. Very rich and valuable deposits of pebble phosphates line the entire river and they are being extensively operated. It is the opinion of those interested in phosphate mining that a channel 3 feet deep could be opened from the Silver Springs, Ocala and Gulf Railroad Bridge at Dunnellon up the river about 18 miles at very little cost. Such a channel would permit of the lightering of the phosphate rock to the mills at Dunnellon, and also would be of great advantage to the immense sawmill interests at this point.

Upper River.—(Panassoffkee.) Large fruit and vegetable farms extend along this portion of the river for 36 miles. The growers depend entirely on water transportation to Panassoffkee, the nearest point on the Florida Central and Peninsular Railroad for transshipment.

Compared with those of 1889, the shipments of fruits and vegetables for 1890 show a decrease. This is accounted for by the excessive rates charged for transportation by the railroads (outside the State of Florida) running into New York. Several thousand crates of vegetables were left in the fields, as they could not be shipped except at a loss to the producers.

Preparations are being made by the steamboat lines for handling the increasing phosphate trade. Difficulty is experienced in getting through the outlet into Panassoffkee Lake, the channel being very narrow and shallow for a distance of 1,600 feet.

Future improvement of the upper river could be made at a small cost, and would be of great benefit to fruit and vegetable producers. The future of the phosphate industries is dependent upon it.

CHAS. R. HILL.

O 12.

IMPROVEMENT OF HARBOR AT CEDAR KEYS, FLORIDA.

The harbor at Cedar Keys is the most northern harbor on the Gulf side of the peninsula of Florida. It is formed by the tidal channels between a group of small islands or keys, of which Way Key, on which is situated the town of Cedar Keys, is the largest. Cedar Keys is the terminus of the central division of the Florida Central and Peninsular Railway. Its principal business is in cedar lumber, though it also forms a distributing point for supplies and general merchandise for an area to the north and south.

An examination of the harbor with a view to its improvement was made in November, 1883. A report thereon, together with a plan of improvement, was printed as Appendix N 30 to the report of the Chief of Engineers for 1884.

PROJECT OF IMPROVEMENT.

The approved project, as there described, is as follows: To obtain a channel 200 feet wide and with a least depth of 10½ feet from Cedar Keys to the Gulf of Mexico. A depth of 9½ feet formerly existed in this

Digitized by Google

channel. The depth is limited by the existence of beds of rock under the entire channel from 9½ to 12½ feet below mean low water, which could only be removed at greater expense than the present and prospective commerce of the port would seem to warrant. The estimated cost of completing this project is $46,500.

On this project appropriations aggregating $19,500 were made by the river and harbor acts of July 5, 1884, August 5, 1886, and August 11, 1888.

The appropriation in the act approved September 19, 1890, was made in the following terms:

Improving harbor at Cedar Keys, Fla.: Continuing improvement, $2,500, a part of which may be expended at Derrick Island Gap on the inside channel from Suwanee River.

OPERATIONS PRIOR TO JUNE 30, 1890.

Between 1872 and 1881 cuts 200 feet wide and 11½ feet deep were made through the middle ground and through the outer bar. Under the appropriation of 1884 a cut 12 feet deep, partly through rock, was started near Buoy No. 12. It was never completed, owing to the exhaustion of the appropriation. The appropriation of 1886 was expended in reopening the cut through the middle ground, giving it a direction as nearly as possible coincident with the direction of the tidal currents. It was made 70 feet wide and 10½ feet deep. The appropriation of 1888 was expended in widening the same cut. Work was begun on June 2, and continued during the remainder of the fiscal year.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1891.

Dredging was continued until July 26; 19,055 cubic yards were removed. When work stopped the cut was 200 feet wide entirely through the middle ground, with a least depth of 9.5 feet, excepting for a width of 60 feet along the east side, where it is 10 feet deep.

Operations under the appropriation of 1890 were postponed until the services of the United States snag boat *Suwanee* should be available. Work will probably be started at an early date.

The commercial importance of Cedar Keys has steadily declined for some years. About the only water traffic that it has now is carried in very light-draft vessels, for which the harbor in its present condition affords ample facilities. I am unable to discover that there is any immediate prospect of an increase in the commerce of this port, and am of the opinion that the improvement there should be discontinued until an increased commerce, actual or fairly prospective, makes the further improvement necessary.

Cedar Keys is in the collection district of St. Marks, of which Cedar Keys is the headquarters. Nearest light-house, Cedar Keys Light; nearest fort is Fort Marion.

Money statement.

July 1, 1890, balance unexpended	$6,917.74
Amount appropriated by act approved September 19, 1890	2,500.00
	9,417.74
June 30, 1891, amount expended during fiscal year	7,270.66
July 1, 1891, balance unexpended	2,147.08
July 1, 1891, outstanding liabilities	86.85
July 1, 1891, balance available	2,060.23
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	44,000.00

Digitized by Google

COMMERCIAL STATISTICS.

Commerce of Cedar Keys, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Cotton ..... bales	147	$4,116	33
Fish and oysters ..... barrels	22,265	89,060	2,783
Fruits ..... boxes	46,000	80,500	1,840
Bananas ..... bunches	1,160	232	12
Pine apples ..... number	10,000	850	15
Grain ..... bushels	3,362	2,857	84
Hides ..... number	2,650	1,325	13
Honey, sirup, etc ..... gallons	1,260	504	9
Lumber:			
Rough (logs) ..... feet	4,000,000	24,000	38,000
Sawed ..... B. M.	2,076,000	41,520	4,152
Merchandise ..... tons	439	32,925	439
Ship stores ..... barrels	100	1,800	20
Vegetables ..... boxes	10,100	12,621	515
Cedar cases ..... number	6,280	62,800	88
Cedar logs ..... feet B. M.	6,032,000	241,284	12,064
Cocoanuts ..... number	6,000	200	8
Total	.....	596,594	60,075

Vessels.	Trips.	Average draft of water.
Local fishing:		*Feet.*
17 sail	29	3
10 schooners	433	9
9 steamboats	73	11
Steamboat *Belle of Suwanee*	100	2½

Passengers, 5,000. Revenue received from same, $20,000.

Estimated percentage of total trade of neighborhood carried by water, 15 per cent.

The business to and from the Suwanee River and the trade with the neighborhood requires light-draft boats only. There is now sufficient water in the harbor and bar channel for all present purposes.

Should there be a call for phosphate shipments from this port further improvement will be necessary.

CHAS. R. HILL.

O 13.

IMPROVEMENT OF SUWANEE RIVER, FLORIDA.

The Suwanee River rises in the southern part of Georgia, near the Okefinokee Swamp, and, flowing in a general southerly direction, empties into the Gulf of Mexico a few miles north of Cedar Keys. The portion examined with a view to its improvement extends from Ellaville to the mouth. The country adjacent is well wooded, and the chief trade is in pine, cypress, and cedar timber, cotton, sirup, the minor farm products, and naval stores. Beds of phosphate rock have been discovered along the upper river.

Previous to the improvement the obstructions in the portion of the river under improvement consisted principally of shoals, composed of soft unstratified limestone mixed with flint, extending either partly or entirely across the river; in some instances covered with shallow deposits of sand and in others bare. The channels across these shoals were often narrow and very crooked, and their depths at extreme low

Digitized by Google

water varied from 15 inches to 3 feet. At other places large isolated limestone bowlders in the channel were constant sources of danger to navigation.

An examination of this river with a view to its improvement was made in 1879. A report thereon dated August 26, 1879, with a plan of improvement, is printed as Appendix J 16, Report of the Chief of Engineers for 1879.

PROJECT OF IMPROVEMENT.

The proposed improvement consists in deepening the bar at the passes by dredging, the removal of snags and overhanging trees along the river, and deepening and improving the channel at various places by the removal of rocks, snags, and construction of dams, so as to straighten, widen, and deepen the channel. The depth to be obtained is 5 feet through the bars at the passes for a width of 150 feet, and up the river as far as New Branford, a distance of 80 miles. From there up to Ellaville, a distance of 50 miles, the depth is to be 4 feet and the width 60 feet.

OPERATIONS PRIOR TO JUNE 30, 1890.

Work was done under the following appropriations:

By act approved—	
June 14, 1880	$5,000
March 3, 1881	3,000
By act passed August 2, 1882	5,000
By act approved—	
July 5, 1884	5,000
August 5, 1886	5,000
By act passed August 11, 1888	15,000
Total	38,000

Ten thousand dollars of the last appropriation were "to be expended in the purchase or construction of a suitable steam snag boat with dredging and pile-driving machinery, to be used on the rivers of the west coast of Florida," leaving the total amount appropriated for work on the river $28,000.

Operations under the appropriations of 1880, 1881, 1882, and 1884, consisted entirely in dredging across the Suwanee Basin at the east pass. On this line the distance from deep water of the gulf to deep water in the river is 15,600 feet. A cut 5,835 feet long, 60 feet wide, and 5 feet deep at mean low water was made, leaving a length of 9,765 feet to be dredged through water having an average depth of 3½ feet. This channel has since partly filled up.

Since 1886 the work in the upper river has comprised removing snags and overhanging trees, blasting and removing rocks and bowlders, and constructing wing dams with the broken rock. A small amount of dredging was done at the Derrick Island Pass at the entrance.

OPERATIONS DURING FISCAL YEAR ENDING JUNE 30, 1890.

An appropriation of $3,000 was made in the act approved September 19, 1890, a portion of the sum being made available for use on the inside channel between the mouth of the Suwanee and Cedar Keys.

After leaving the Caloosahatchee River, the United States snag boat

Digitized by Google

Suwanee was overhauled and repaired at Tampa. On May 17th she arrived at New Branford, on the Suwanee. From that date until the close of the fiscal year she has worked between New Branford and Ellaville, principally at Double Island. Strip Jacket, and Peacock shoals and opposite the mouth of the river Styx. Logs and snags and 526.4 cubic yards of rock were removed from the channel. As a result a navigable channel 3 feet deep at the lowest stage of water was opened to Hudson.

The narrow, crooked channels, rapid currents, and rocky bed of that portion of the river between Ellaville and Branford render navigation dangerous whenever the water is low.

From Branford to the mouth the channel is in good condition. The channel through the Suwanee Basin is crooked, narrow in places, and has a least mean low-water depth of but 3 or 4 feet.

FUTURE OPERATIONS.

The Suwanee River commerce comprises the movement of freight, farm produce, and naval stores to and from the railoads at Ellaville, New Branford, and Cedar Keys, and the rafting of cedar and other timber to the mills of the same towns. The roads are few and bad, and bulky produce can only be moved to advantage by water, so that an improvement of the stream which will make it continuously navigable is essential to the prosperity of the river valley. Excepting the traffic to and from Cedar Keys, there is no movement of freight out of the mouth of the river. This fact renders it unnecessary to extend the cuts previously made through the Suwanee Basin to the deep water of the Gulf, and restricts the work under the project which the present commercial status renders necessary, to the clearing of the river channel proper and the dredging of the oyster bars from the Derrick Island Pass at the mouth. After the improvement has been made, the channel can be kept clear with an estimated annual expenditure of $800.

The Suwanee River is in the collection district of St. Mark's. Cedar Keys is the nearest port of entry. Nearest fort is Fort Marion. Nearest light-house, Cedar Keys Light.

Money statement.

July 1, 1890, balance unexpended	$663.13
Amount appropriated by act approved September 19, 1890	3,000.00
	3,663.13
June 30, 1891, amount expended during fiscal year	2,340.20
July 1, 1891, balance unexpended	1,322.93
July 1, 1891, outstanding liabilities	689.42
July 1, 1891, balance available	633.51
Amount (estimated) required for completion of existing project	24,158.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Digitized by Google

COMMERCIAL STATISTICS.

Commerce of Suwanee River, Florida, during the year ending December 31, 1890.

Articles.	Quantity.	Estimated value.	Gross tonnage.
Cotton.....bales..	1,592	$119,400	318
Fertilizers.....tons..	110	2,750	110
Fish and oysters.....barrels..	700	3,500	11
Fruits.....boxes..	1,500	2,000	38
Grain.....bushels..	61,362	52,157	1,534
Hides.....number..	2,751	1,375	14
Honey, sirup, etc.....gallons..	15,080	7,032	90
Lumber:			
Rough.....feet..	15,000,000	75,000	142,500
Sawed (logs).....B. M..	10,076,000	201,538	20,155
Merchandise.....tons..	5,635	422,625	5,635
Ship stores.....barrels..	25,018	175,125	6,000
Vegetables.....boxes..	9,600	9,600	480
Cedar logs.....B. M..	1,435,000	57,400	2,392
Cedar cases.....cubic feet..	5,435	104,410	109
Total.....	.....	1,233,912	179,386

Vessels.	Average tonnage.	Average draft of water.
Steamboats:		*Feet.*
Belle of Suwanee	180	2½
Dolphin	10	1½
Wekira	10	2

Passengers, 7,800. Revenue received from same, $31,200.

Estimated percentage of total trade of neighborhood carried by water, 75 per cent.

Probable increase of trade were the improvement completed, 33 per cent.

Remarks.—There is a steady increase of tonnage on this river, due entirely to the improvements made and being made, the removal of obstructions and the deepening of shoal places rendering much service to navigation.

Almost the entire tonnage of the Suwanee River goes to Branford for reshipment by rail.

CHAS. R. HILL.

O 14.

PRELIMINARY EXAMINATIONS OF ST. JOHNS RIVER, FLORIDA, FROM JACKSONVILLE TO SANFORD; AND THE UPPER PART OF ST. JOHNS RIVER, FROM LAKE MONROE SOUTHWARD.

[Printed in House Ex. Doc. No. 240, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 5, 1891.

SIR: I have the honor to submit the accompanying copy of report, dated January 26, 1891, by Capt. Wm. M. Black, Corps of Engineers, giving the results of preliminary examinations made in compliance with requirements of the river and harbor act approved September 19, 1890, as follows:

(1) St. Johns River, from Jacksonville to Sanford, Fla., to obtain an estimate of the cost of deepening the channel so as to secure navigation for ocean steamers, and to report separately the cost of opening the channel of the river in the vicinity of Orange Mills.

(2) The upper part of the St. Johns River, from Lake Monroe southward, or in a southerly direction, through the river and connecting lakes to the head of steamboat navigation.

Digitized by Google

It is the opinion of Captain Black, concurred in by the Division Engineer, Col. Wm. P. Craighill, Corps of Engineers, that the localities named are not worthy of improvement, and this opinion meets with my approval.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 26, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of St. Johns River, Florida:

(1) "From Jacksonville to Sanford, to obtain an estimate of the cost of deepening the channel so as to secure navigation for ocean steamers, and to report separately the cost of opening the channel in the vicinity of Orange Mills."

A steamer 350 feet long, 45 feet beam, and drawing 10 feet of water is assumed to be the type of boat for which the estimate for channel improvement is desired. Such a boat requires a channel 100 feet wide in a perfectly straight reach. She can not be handled safely in an ordinary curved channel less than 200 feet wide. The least radius in which she can turn on the open sea would vary from 500 to 1,000 feet; 1,500 feet is assumed as the least radius of a curve which she can make in a confined channel. To form a channel from Jacksonville to Sanford having a navigable depth of 10 feet, a minimum width of 200 feet, and with no curves of less than 1,500 feet radius, 1,362,000 cubic yards of sand and silt must be removed from straight reaches and 30 bends must be straightened by dredging 3,469,000 cubic yards in addition. Taking the cost of dredging at 30 cents per cubic yard, which, as it must include clearing the land of trees and roots, is not excessive, and adding 15 per cent. for contingencies, the total cost of this work would be $1,460,000. Each foot of depth required in addition would add to this cost proportionably.

Ten feet can now be carried to Palatka and for 14 miles beyond, as far as Little Lake George. To deepen this channel to 12 feet as far as Palatka would require 170,000 cubic yards of dredging, costing $58,600, to which must be added $25,000 for training walls in the vicinity of Orange Mills necessary to maintain the dredged cuts there. The volume of dredging in that vicinity, included in the 12-foot estimate to Palatka, is 118,000 cubic yards, and the cost is $40,700.

I am unable to see that any useful purpose would be served by the proposed improvement. All of the legitimate demands of trade can be met by the steamboat and train service from up-river ports to the city of Jacksonville, where transshipments can be made to ocean vessels. If the improvements were made, beyond an occasional lumber schooner, it is not probable that the channel would be used to any extent. Bulky products would have to be brought by rail to the river then as now, and the additional haul to Jacksonville is not much of a burden.

Transatlantic shipments could not be made profitably in vessels of such light draft. Commerce would be much better served by complet-

Digitized by Google

ing the existing project of a 15-foot channel to Jacksonville, for which the estimated amount as yet unappropriated is $640,000, or, still better, by forming a channel 20 feet deep to Jacksonville, at a cost of about $235,000 additional. The estimates for work on the upper river are made from the data given in the charts of the U. S. Coast and Geodetic Survey. Closer estimates could be made from a more detailed survey. This would be quite expensive and I do not deem it required, as I do not regard the proposed improvement of the upper river as necessary.

While the present and prospective demands of commerce do not warrant the formation of a channel for ocean-going steamers, it is my opinion that they do warrant such an improvement of the channel as will permit the free navigation by the river steamers. The largest of these, the *City of Jacksonville*, is 160.5 feet long, 32.5 feet beam, and 7.7 feet depth, and has a gross tonnage of 460 tons. She is ordinarily loaded to a draft of 5 feet. In her trips between Jacksonville and Sanford she is frequently delayed at Volusia Bar (at the south end of Lake George) and in the bends between that point and Sanford. At Volusia Bar the channel has been deepened and held by jetties, but the lake beyond their extremities is so shoal that the annual deposits from freshets in the upper river have gradually built up a bar beyond their ends. Dredging from time to time will always be required here. In 1879, and again in 1884, a project was submitted by the late General Gillmore to straighten three of the worst bends above Lake George at an estimated cost of $38,000. Five thousand dollars were appropriated for this work, but as this sum is entirely insufficient it has not been expended. With a properly equipped snag and dredge boat the river could be cleared of snags, its bars removed, and its worst bends straightened at comparatively small expense. Such a boat would cost $15,000 and she could be operated at a cost of about $8,000 per annum. In the St. Johns River and its navigable tributaries she is greatly needed. As given in the Annual Report of the Chief of Engineers for 1890, the commerce of the St. Johns River which passes Volusia Bar annually is about 15,500 tons, consisting of fertilizers, fruits, vegetables, breadstuffs, hides, and general merchandise, valued at $847,000.

(2) The upper part of St. Johns River "from Lake Monroe southward or in a southerly direction through the river and connecting lakes to the head of steamboat navigation."

This portion of the river is shown on Coast Survey chart, No. 455*a*[2]. An attempt was made to examine it November 18 to 21, 1890. After passing the mouth of Salt Lake Run, 36 miles south of Sanford, the river was found to be completely blocked with lettuce and careless weed packs. I learned that these packs extended through the next 10 miles of the stream, so that it was quite impossible to pass them in the time available for the examination. Sufficient information was obtained, however, to enable a report to be made.

The St. Johns River south of Lake Monroe has a navigable depth at least as far as Lake Washington (93.5 miles) and probably farther. The land bordering its banks is low and marshy for many miles, especially south of Lake Harney, 17 miles from Lake Monroe. Good high land can be reached through the connecting lakes and tributaries, notably Lake Jessup, and if the stream were in condition for free navigation a large territory, some of which is now under cultivation, would be opened up. At present crops are of little or no value, owing to the difficulties of transportation. Before the construction of the railroad to Titusville, on the Indian River, a line of boats ran from Sanford to the head of

Digitized by Google

Lake Florence, which empties into Lake Poinsett, there connecting with stages for Rockledge, distant 3 miles. Excepting in Lake Harney there is a navigable depth of over 4 feet throughout the entire reach.

In Lake Harney the low-water depth falls to 3 feet or less. The river is crooked, at places obstructed by water weeds and at others by lettuce packs. This last obstruction at times takes the form of floating dams, closely packed, 3 feet thick and 100 or 200 feet across. Such dams can not be broken by light craft, but must be torn away piece by piece, a work of much labor. Regular navigation of the river would, however, prevent their formation.

Definite information relating to the probable commerce of the upper river can not be obtained. I have the honor to invite attention to the estimates of Messrs. Shaw and Howard, given in the inclosed letters. These gentlemen are well acquainted with the region. I believe that were the river opened there would be sufficient work for at least a weekly steamer at once, with a future increase. I do not think that this portion of the river is now worthy of improvement alone. If, however, the services of a snag and dredge boat, as recommended for the river below Sanford, were available, the river could be kept open at so slight an outlay, probably not exceeding $600 per year, as to make it well worthy of improvement.

Very respectfully, your obedient servant,

WM. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., February 2, 1891.

Respectfully submitted to the Chief of Engineers.

Because of the facts and reasons stated in the report of January 26, 1891, by the local engineer, and from my own knowledge, I am of the opinion that the St. Johns River from Jacksonville to Sanford is not worthy of such improvement as would "secure navigation for ocean steamers" and include "the opening of the channel in the vicinity of Orange Mills;" and the same is my conclusion concerning "the upper part of the river from Lake Monroe southward or in a southerly direction through the river and connecting lakes to the head of steamboat navigation."

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

LETTER OF MR. W. A. SHAW.

DEAR SIR: Regarding letter of Mr. Eger respecting the navigation of the upper St. Johns River and the volume of business tributary, I, in compliance with your request, desire to make the following statement:

As for the navigation of the St. Johns River from Jacksonville to Sanford, the Light-House Board has properly lighted same, and I would recommend, if possible, that Captain Black cut off all points, six in number, so as to facilitate our time to Sanford. If these points were cut off we could make the run from Jacksonville to our terminal without ringing a bell, and shortening our time nearly 1 hour to Sanford.

Digitized by Google

The upper St. Johns, from Sanford to Poinsett, so far as the depth is concerned, shows 7 feet all the way to the above-mentioned place. Monroe Bar, the east end, also Harney bars, north and south end, should be deepened to 5 feet. The upper portion south of Harney could be shortened quite a number of miles by opening up a channel across points, which could be easily done, as they would only have to encounter saw grass.

The volume of business from Sanford to Lake Harney would amount to, approximately, 200,000 boxes of oranges, in addition to a number of crates and barrels of vegetables, as I know of one man being reputed as having 1,000 barrels of eggplants. At Lake Jessup the Oveido and Lake Charm country is one of the most productive orange-growing sections in the State; south of that, at Geneva, also at Balsam Landing and Cook Ferry, at Harney, there is considerable business that could be worked up if we had the steamer *Welaka* running there twice a week from Harney to Jacksonville. In addition to the river service receiving the benefit, the steamships would get quite an amount of business that now goes via Ocean Steamship Company, simply on account of going via rail. The growers have to haul quite a distance to the road and would prefer doing so to the river, as it is invariably shorter and gives more satisfaction.

As regards obstructions south of Lake Monroe, there are none, except that one point being cut off and the bars deepened.

Hoping my explanation is satisfactory, I am yours, very respectfully,

W. A. SHAW.

Maj. J. A. LESLIE,
Superintendent Clyde Line, Jacksonville, Fla.

LETTER OF MR. JOHN L. HOWARD.

JACKSONVILLE, FLA., *November 3, 1890.*

DEAR SIR: Some years ago I was purser on a steamer that ran from Jacksonville as far south as Lake Harney, on the upper St. Johns. Owing to the good service on the river to this point (Lake Harney) the traffic increased from year to year until it was quite an item for the river steamers.

The building of larger steamers in later days and the poor condition of the river above Lake Monroe necessitated their making Sanford the terminal point, and since then there has been no steamer communication above Lake Monroe. In looking over the territory adjacent to the St. Johns River Valley, which has been without any steamer, it would seem to me that if the river was in a condition so that a steamer the size of the *Welaka* could go as far south as Lake Poinsett, it would bring again into notice this section rich in vegetable lands, besides already a large orange section.

From Lake Jessup south as far as Lake Harney, in all, each season as follows:

	Oranges.
Jessup (immediately on lake)	50,000
Lemon Bluff	3,000
Osteen	5,000
Lake Harney	15,000

With a good service the vegetable shipments would reach 25,000 bushel crates. South of Lake Harney, at Salt Lake, there would be quite a traffic in vegetable shipments.

At Lake Poinsett with a tramroad to Rockledge would touch about 30,000 boxes of oranges, pineapples, and vegetables, also large shipments of vegetables and oranges from the Lake Winder section, 12 miles south of Lake Poinsett. Shipments of oranges and vegetables from Lake Winder find an outlet down the river to Poinsett by flatboat, thence by wagon across to Indian River, and steamer to Titusville.

Yours, truly,

JNO. L. HOWARD.

Maj. J. A. LESLIE,
Superintendent, Jacksonville, Fla.

Digitized by Google

O 15.

PRELIMINARY EXAMINATION OF HARBOR OF ST. AUGUSTINE, FLORIDA, FOR IMPROVEMENT OF CHANNEL SO AS TO MAKE A DEEP-SEA CHANNEL OVER THE OUTER AND INNER BARS.

[Printed in House Ex. Doc. No. 291, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 2, 1891.

SIR: I have the honor to submit the accompanying copy of report, dated February 24, 1891, from Capt. W. M. Black, Corps of Engineers, giving results of preliminary examination of the harbor at St. Augustine, Fla., "for improvement of channel so as to make a deep-sea channel over the outer and inner bars," made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Black reports that under the present existing conditions he does not regard the formation of a deep-sea channel across the outer and inner bars at this place as necessary, and is compelled to report that the locality is not worthy of improvement.

Col. William P. Craighill, Corps of Engineers, Division Engineer, Southeast Division, reports that it is evident that there is no need of such an improvement at a cost of $1,500,000, and he is therefore unable to state that the locality is worthy of improvement.

I concur in the views of these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., February 24, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of the harbor of "St. Augustine, for improvement of channel so as to make a deep-sea channel over the outer and inner bars."

An examination and survey of this harbor was made in 1886 and 1887 under the provisions of the river and harbor act of August 5, 1886. The reports thereon are printed in Appendix O of the Report of the Chief of Engineers for 1888. The engineer in charge reported that in his opinion the harbor was worthy of improvement, and submitted a project for deepening the channel at the harbor entrance to 16 feet at mean low water, at an estimated cost of $1,468,000. In the act of August 11, 1888, $35,000 was appropriated, with the proviso that a Board of Engineer Officers should be appointed to examine the harbor and to report on the expediency of improving it on the plan submitted. The report of the Board, with the comments of the Chief of Engineers and of the Secretary of War, is printed in Appendix P of the Report of the Chief of Engineers for 1889.

The Board reported that "the harbor * * * has fine interior facil-

Digitized by Google

ities for becoming a commercial port," having "deep water, a good anchorage, and a sheltered position in storms." * * * But that its bar, being of shifting sand, is difficult of improvement. It further reported that in its opinion the project submitted "promises success if funds are supplied regularly and in large annual appropriations."

Under these conditions, and considering the proximity of other ports now under improvement, the Board reported that "it is for the wisdom of Congress to decide whether it be expedient to undertake the improvement of another port in this vicinity before the four now in progress are completed." In these views the Chief of Engineers and the Secretary of War concurred.

The funds available were expended in works for stopping the erosion of the shores at the harbor entrance. An appropriation of $20,000, made in the act approved September 19, 1890, is being expended for the same purpose. No appropriation has been made for the deepening of the channels.

Since the above reports were rendered the commercial needs of St. Augustine have remained practically unchanged. The development of the phosphate industry of Florida has increased the necessity for deep seaports, and St. Augustine is the Atlantic coast port nearest the phosphate belt. At present the railway combinations are such that no phosphates can seek an outlet here.

Should the railway conditions be changed so as to enable phosphates to be shipped most cheaply via St. Augustine, and should the East Coast Canal from the Indian River be extended to this port, I would regard the formation of a deep-sea channel into the harbor as an economic necessity. Under the existing conditions I do not regard the formation of a deep-sea channel across the outer and inner bars as necessary, and, in accordance with the law, I am compelled to report that the locality is not worthy of improvement.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., February 27, 1891.

Respectfully submitted to the Chief of Engineers.

Because of the facts and reasons given by the local engineer there is evidently no need of the improvement at St. Augustine, Fla., at a cost of $1,500,000, so as to make a deep-sea channel over the outer and inner bars; and I am therefore unable to state, in the words of the law, that the locality is "worthy of improvement."

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

Digitized by Google

O 16.

PRELIMINARY EXAMINATION OF INDIAN RIVER, FLORIDA, BETWEEN TITUSVILLE AND JUPITER INLET.

[Printed in House Ex. Doc. No. 168, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 8, 1891.

SIR: I have the honor to submit herewith copy of report, dated December 31, 1890, by Capt. William M. Black, Corps of Engineers, upon preliminary examination of Indian River, Florida, between Titusville and Jupiter Inlet, made to comply with provisions of the river and harbor act approved September 19, 1890.

This river is not regarded as worthy of improvement by the General Government until the Florida Coast Line Canal and Transportation Company surrenders and relinquishes to the United States all the rights and privileges it now holds under State charter along the entire route.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., December 31, 1890.

GENERAL: I have the honor to submit the following report on the preliminary examination of "Indian River, between Titusville and Jupiter Inlet," made November, 1890, in accordance with Department letter dated September 20, 1890.

The portion of Indian River named is shown on charts Nos. 161, 163, 464, and 464*c* to 464*h*, inclusive. The length of the reach is 128 miles. The width varies from 5 miles near Titusville to 500 feet in Indian River Narrows, and 75 feet in Jupiter Narrows (in the channels used by the boats). There is a continuous broad channel, with a least depth of 6½ feet, from Titusville south for 47 miles, as far as Goat Creek. From this point south the natural channel is interrupted by numerous shoals and bars, having on them a low-water depth of from 2½ to 4 feet.

The Florida Coast Line Canal and Transportation Company, a company duly incorporated under the laws of the State of Florida, has made a number (23) of dredged cuts across the shoals through this defective reach, making a continuous navigable channel 50 feet wide and 5 feet deep at low water, extending to Jupiter Inlet. The aggregate length of the cuts made by this company is 39,500 feet. Under its charter the company "is authorized to own vessels and navigate the water way; to levy tolls on its cuts and channels improved, and to operate telegraph and telephone lines." (Prospectus of company, January, 1890.)

The Indian River is the only highway available for the products of the fertile strip of high land which forms the east coast of Florida, between Titusville and Key Biscayne Bay, a distance of 200 miles. The land on both sides of the river is unsurpassed in the State for the cultivation of

Digitized by Google

vegetables and semitropical fruits. Bounded on the east by the ocean and on the west by the lowlands west of the Upper St. Johns River and of the Okeechobee region, it is cut off from the general railroad system of the State, which touches it only at Titusville. During the past few years the development of this country has been very rapid. Steamers now run daily between Titusville and Melbourne throughout the year, and triweekly in summer and daily in winter between Melbourne and Jupiter Inlet. These boats are light-draft stern-wheel steamers with gross tonnage of about 150 tons, with a capacity of from 100 to 130 passengers. Their capacity has been tried to the utmost in the past, and the indications are that they will not be able to accommodate the winter travel of this year. As the young groves of oranges and bananas and the pineapple plantations, already set out, come into bearing, year by year, the commerce of the river will be greatly increased. According to a careful estimate made one year ago, the present commerce is as follows:

Vegetables	barrels..	1,738
Do	crates..	28,970
Oranges	do....	69,842
Lemons	do....	210
Pineapples	number..	691,250
Bananas	bunches..	6,410
Limes	barrels..	3
Do	crates..	300
Strawberries	do....	50
Honey	barrels..	4
Sirup	do....	75
Mangoes	do....	10
Guavas	do....	80
Do	crates..	100
Guava jelly	cases..	500
Fish and oysters	barrels..	950
Turtle	pounds..	10,600
Venison	do....	2,400
Inward freight for 6 months ending December 31, 1888	tons..	2,282½

The present facilities for navigation are insufficient. Owing to the slight depth available the traffic must be carried on in vessels of very light draft. To obtain the necessary tonnage they must be long and of broad beam. The *St. Lucie*, one of the steamers navigating the river, is 120 feet long on deck, 28 feet extreme beam, has a gross tonnage of 165 tons, and is licensed to carry 130 passengers. Vessels of this character have slight hold on the water and are difficult to manage in the brisk winds which prevail throughout the year in this river, so close to the ocean. The width of the canal company's cut, 50 feet, is insufficient, and the boats are continually delayed by grounding on the banks. In Jupiter Narrows the channel is narrow and crooked and closely hemmed in by a dense growth of mangroves.

The improvement needed is to make a continuous channel 5 feet deep at low water and at least 75 feet wide in the straight reaches, with as much greater width in the turns as may be required by widening the cuts of the canal company and making new cuts where needed and by removing some of the mangroves in the narrows. As the inlets to the ocean close from time to time, and as free tidal circulation is necessary for keeping the channels open, as well as for the preservation of health, provision should be made for the small amount of dredging required from time to time for this purpose (Jupiter Inlet was reopened during the past year at a total cost of $300). The estimated cost of this work is $44,000.

I regard this river as worthy of improvement by the United States.

Digitized by Google

The commerce of the river is large and increasing, and the State of Florida has already done much, having deeded the canal company 391,680 acres of her land for the work already done between Titusville and Jupiter Inlet. As the East Coast Canal and Transportation Company holds certain rights and privileges under the State charter (among them may be that of collecting tolls on the improved water way), should the United States determine to undertake the further improvement of the river I would recommend that no work be done until all rights or claims over the reach to be improved be abrogated, either by act of the legislature or by a voluntary surrender on the part of the proper officers of the company. As I have been given to understand that it is not the intention of the company to attempt to collect tolls in the reach named, and as its further improvement would enhance the value of the lands of the company, it is probable that this would be promptly done. For an opinion on the present rights of the company in this reach I have the honor to ivite attention to the appended copy of a letter from the Hon. F. P. Fleming, governor of the State of Florida.

The estimate given here is only approximate. To obtain the data necessary for a close estimate a survey would be necessary. This could be made at a cost of $750.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., January 6, 1891.

Respectfully submitted to the Chief of Engineers.

Because of the facts and reasons stated by the local engineer in his report of December 31, 1890, and from my own knowledge, it is my opinion that the improvement of Indian River, Florida, between Titusville and Jupiter Inlet, is worthy to be undertaken by the United States, but not until the Florida Coast Line Canal and Transportation Company have fully given up all rights and privileges they may have acquired on the route.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

LETTER FROM GOVERNOR OF FLORIDA.

STATE OF FLORIDA, EXECUTIVE DEPARTMENT,
Tallahassee, December 11, 1890.

SIR: I am in receipt of your favor of the 6th instant, requesting information as to the status of the Florida Coast Line Canal and Transportation Company, under its charter granted by the State of Florida, whether it has complied with and been paid for its work on that part of its route on Indian River between Titusville and Jupiter Inlet, and whether all improvements made thereon are public property, and my opinion on the subject.

This company was organized May 23, 1881, under the general law for the incorporation of railroads and canals. Its original charter provided for the cutting of canals between the Mantanzas and Halifax Rivers and betweed Mosquito Lagoon and Indian River. The articles of incorporation were amended from time to time so as to au-

Digitized by Google

thorize the opening to navigation of a continuous water way from the St. Johns River to Key West.

By an act of the legislature approved February 6, 1885 (chapter 3641, laws of Florida), a grant of 3,840 acres per mile of any State land within 10 miles of the canal was made to the company. The trustees of the internal-improvement fund of the State of Florida held, as against the claim of the company, that they were not entitled to the land for water ways on the route where no cutting or dredging was necessary, but the last legislature, by an act approved May 29, 1889 (chapter 3955, laws of Florida), extended the land grant so as to include as mileage, for which 3,840 acres per mile is granted, the whole distance from St. Augustine to Biscayne Bay, and directed the trustees to convey to the company from time to time as its work progressed, 3,840 acres of land per mile, within the 10-mile reservation, from St. Augustine to Biscayne Bay, provided that no deed should be made for any section of said canal for a distance of 102 miles from mile 24 to mile 126 south of St. Augustine until the canal shall be constructed, connecting the divide between the Matanzas and Halifax rivers. It was also provided by the said act that the canal and water ways should be not less than 50 feet wide and 5 feet deep at mean low water.

Upon the application of the company and report that they had completed their canals and water ways from Jupiter, in Dade County, to the west end of Haulover Cut, in Brevard County, in conformity with the specifications, Col. John Bradford, an engineer, was sent by the trustees to inspect the work, which he did, and reported August 6, 1890, that it had been completed in accordance with the specifications between the said points, including in his report a schedule of distances from St. Augustine by the line of the canal and water ways, showing the Haulover to be 94 miles, Titusville 104 miles, and Jupiter Inlet 230¼ miles from St. Augustine. Upon the report of Colonel Bradford and in compliance with the provisions of the statute, the trustees conveyed to the company lands for the water way and canals from the point 126 miles south of St. Augustine for 102 miles southward, extending practically to Jupiter Inlet.

The grant of lands to the canal and railroad companies, under the law, is not intended for full compensation for the construction of the work, but to assist, encourage, and promote public improvements. As a railroad, when completed, is a public thoroughfare of travel, yet the company, as common carriers, have control of the means of transportation, and are entitled to reasonable compensation for the carriage of passengers and freight, so the same rights appertain to a company which constructs and operates a canal. Whether this company may exercise any exclusive rights or be entitled to compensation or toll for the use of that part of the route which was a public water way prior to their operations, though the navigable capacity of the same has been increased and improved by their work, is a serious question of law, upon which I do not think it would be proper for me to express an opinion at this time. If an issue should arise in reference thereto it would have to be settled by the courts.

Copies of the report of the State engineer and the action of the board of trustees thereupon have been made by the secretary of the board, which, I understand, are intended for your information; otherwise I would send you copies direct.

Any other information in reference to the matter which I can furnish you will be cheerfully done.

I have the honor to be, very respectfully,

F. P. FLEMING,
Governor.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

O 17.

PRELIMINARY EXAMINATION OF CHANNEL LYING NORTH AND WEST OF THE TOWN OF CEDAR KEYS, FLORIDA, KNOWN AS BOAT OR NUMBER FOUR CHANNEL.

[Printed in House Ex. Doc. No. 205, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 22, 1891.

SIR: I have the honor to submit the accompanying copy of report dated January 14, 1891, by Capt. W. M. Black, Corps of Engineers, upon the preliminary examination of "channel lying north and west of

Digitized by Google

the town of Cedar Keys, known as Boat or No. 4 Channel, Florida," made in compliance with requirements of the river and harbor act approved September 19, 1890.

It is the opinion of Captain Black, concurred in by the Division Engineer, Col. Wm. P. Craighill, Corps of Engineers, that the locality is not worthy of improvement. The views of these officers meet with my approval.

Very respectfully, your obedient servent,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 14, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of Boat or No. 4 Channel, harbor of Cedar Keys, Fla.:

The examination was made November 13 and 14 by Mr. J. W. Sackett, assistant engineer. Especial pains were taken, as a claim had been made and vehemently urged that deep water could be carried through this channel to the town of Cedar Keys, and that the harbor chart of the U. S. Coast and Geodetic Survey was incorrect. Mr. Sackett found that the available channel depth, as shown by over one thousand soundings taken in courses running where the deep water was claimed to exist, to be 8 feet at mean low water.

Excepting as a distributing point for supplies shipped in small steamers and sailing craft to the Withlacoochee and Suwanee River valleys and the surrounding country, Cedar Keys has practically no commerce at the present time, and there is no present necessity for the deepening of No. 4 Channel. I have the honor to report that I do not regard it as worthy of improvement. The report of Mr. Sackett is inclosed.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., January 21, 1891.

Respectfully submitted to the Chief of Engineers.

Because of the facts and reasons stated in the report of January 14, 1891, by the local engineer, and from my own knowledge, it is my opinion the improvement of No. 4 Channel, harbor of Cedar Keys, is not necessary, and therefore I say, in the words of the law, it is not worthy of improvement.

W. P. CRAIGHILL,
Colonel, Corps of Engineers.

Digitized by Google

REPORT OF MR. J. W. SACKETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 13, 1891.

CAPTAIN: I have the honor to report that in accordance with your instructions I proceeded to Cedar Keys and, on November 13 and 14, made a preliminary examination of Boat or No. 4 Channel, near that place.

The belief that a greater depth of water existed in this channel than is shown on the charts of the United States Coast Survey seemed generally prevalent at Cedar Keys. My party was made up of men quite familiar with all that vicinity. I had for a pilot Capt. William Wilson, who, I was told, had probably piloted more vessels into No. 4 Channel than any other man.

We spent the greater part of November 13 and a part of the 14th tracing this channel. The sounding lines were run on compass courses, and the beginning and ending of each line and the points of deflection were located by bearings to three prominent objects. Over 1,000 soundings were recorded. As far as I have been able to ascertain, my soundings correspond in general with those shown on the Coast Survey chart, and they show that No. 4 Channel has an available depth of only 8 feet at mean low water.

Under the circumstances, I do not think that the present commerce of Cedar Keys or the prospective commerce of the near future would warrant the necessary expenditure for the improvement of this channel; therefore I would respectfully recommend that no improvement be attempted at present.

Very respectfully, your obedient servant,

J. W. SACKETT,
Assistant Engineer.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

O 18.

PRELIMINARY EXAMINATION OF PEACE [PEASE] RIVER, FLORIDA.

[Printed in House Ex. Doc. No. 241, Fifty-first Congress, second session.]

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 12, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of Pease Creek, Florida:

Three appropriations have been made for the improvement of Pease Creek or Pease River, aggregating $13,000. A portion of this sum was expended in mapping the river and the remainder in snagging operations (1882–1884). As the work was not completed, owing to the exhaustion of the appropriation available, no useful result was obtained. Excepting over short reaches, the river is not navigable. The approved project is to open the river for navigation by boats drawing 2 feet of water, during one-half the year, with a minimum channel width of 30 feet, by rock excavation and removing snags and overhanging trees, from the mouth to Fort Meade.

The development of the phosphate mining industry in the Pease Creek valley has vastly increased the need for transportation facilities. If Pease Creek were navigable during the entire year undoubtedly the volume of trade using it would be very great. Unfortunately the upper reaches of the stream are narrow and crooked, with banks frequently low and generally of light material, easily moved by the water; the river-bed is obstructed by rock ledges and shifting bars, and the stream itself is subject to rapid and great fluctuations of level.

At its lowest stage the stream in the channels around the bends contracts to a mere thread of water, while on the few rocks and sand shoals that extend across the channel from bank to bank the water covers the entire river bed, but is too shallow to carry a skiff drawing even 6 inches. (Report of J. L. Meigs, assistant engineer, Report of Chief of Engineers, 1880, part 2, page 1105.)

Digitized by Google

For these reasons the present limited project was adopted.

The lower portion of the river is, however, more capable of improvement; 5 feet can now be carried as far as Fort Ogden, 18 miles from the mouth, and 10 feet as far as Punta Gorda. The channel could be deepened to 8 feet as far as Fort Ogden for $34,000, and this should be done as soon as the development of the phosphate industry near Fort Ogden and Liverpool becomes sufficiently great to warrant this expenditure. From all points above Fort Ogden it will be necessary to use rail transportation for so large a portion of the year that it would not be in the interests of economy for the phosphate companies to depend upon the river at all. Once loaded for the cars it would not pay to transship the phosphate at any point short of the terminus of the railway or of deep water.

With the appropriation of $35,000, made in the act approved September 19, 1890, the channel will be deepened at the mouth of the river as far as the railroad wharf at Punta Gorda. Should the railway be extended to the deep water at Boca Grande Pass I do not deem a further improvement of the channel here necessary. Should the railway not be extended the channel at the mouth should be deepened to 15 feet at mean low water in connection with the improvement of Charlotte Harbor.

I have the honor to submit herewith letters from Messrs. M. T. Singleton, Jos. Hull, and H. Robinson relating to the improvements desired.

For the commercial statistics of Pease Creek I have the honor to invite attention to the Annual Report of the Chief of Engineers for 1890.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., January 17, 1891.

Respectfully submitted to the Chief of Engineers.

In section 17 of the law of September 19, 1890, this stream is called "Peace River." In section 1, where mentioned in connection with the improvement of Charlotte Harbor, into which it empties, it is called "Pease Creek."

Because of the facts and reasons set forth in the report of the local engineer of January 12, 1891, and from my own knowledge, it is my opinion that the stream is not worthy of improvement above Fort Ogden, 18 miles above the mouth.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
St. Augustine, Fla., January 27, 1891.

Respectfully returned to the Chief of Engineers, U. S. Army.

It is my opinion that Pease River is not worthy of improvement above Fort Ogden; that it is worthy of improvement below Fort Ogden; that there is no pressing necessity at present for the improvement

Digitized by Google

between Fort Ogden and Punta Gorda; and that the improvement below Punta Gorda is necessary only in connection with the improvement of the channels through Charlotte Harbor, between Boca Grande entrance and Punta Gorda.

W. M. BLACK,
Captain, Corps of Engineers.

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., February 2, 1891.

Respectfully forwarded to the Chief of Engineers.

In my opinion Pease River is worthy of improvement below Fort Ogden.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

LETTER OF MR. M. T. SINGLETON.

ARCADIA, FLA., *December 8, 1890.*

DEAR SIR: Your letter of the 5th instant is just received. I am compelled to leave for Charlotte Harbor to-morrow to dispatch a cargo of rock, but hope to get back in time to meet you. If I should fail to do so my brother, Mr. J. J. Singleton, will take pleasure in giving you all the information he can, and will also furnish you with boats and oarsmen to facilitate your investigations should you need them.

I have not seen the text of the last river and harbor bill, and do not know the nature of the clause referring to Pease River. I infer from your letter that it only contemplates an examination and report. In case I should fail to meet you I will take occasion to say here that the Pease River Phosphate Company does not consider the possible opening of the river as a factor in its business. Water transportation to the Gulf would, of course, be of immense value to us, and any assistance from the Government in that direction would be appreciated; but we could at best utilize the river for only a portion of the year, and I doubt if it would materially benefit us. I take the liberty to say this much, as you kindly state that you wish to consult us "concerning the needs of navigation," etc. The banks of the river are so unstable, the volume of water so small during the dry season, and the material in the channel so mobile that we could hardly expect the Government to expend the sum necessary to make the stream navigable all the year and maintain it in that condition. You, however, can best judge of the feasibility of making the river navigable at low water. If such a thing can be accomplished the benefits to us will be almost incalculable, and we would transport by the river not less than 50,000 tons per annum.

To state the matter briefly, the expenditure of a small sum would not benefit us in the least, and nothing would benefit us short of actual navigation all the year round.

Very respectfully yours,

M. T. SINGLETON,
Engineer and Superintendent.

Capt. W. M. BLACK,
Corps of Engineers, U. S. A.

LETTER OF MR. JOS. HULL.

ARCADIA PHOSPHATE COMPANY,
Savannah, Ga., December 15, 1890.

DEAR SIR: Mr. T. S. Moorhead has informed us of an interview he had with you in regard to making Peace River navigable at high water, and whether or not high-water navigation would be of any benefit to us. We beg to state that high-water navigation would not be of the slightest value to us. We have secured a rate by rail from our works to Charlotte Harbor of 50 cents per ton, which is much cheaper than

Digitized by Google

it could possibly be barged from Arcadia to Charlotte Harbor. Again, we could not afford to equip and maintain a fleet of barges with tugboat simply to work on high water, which only lasts a very short time at intervals. The river rises and falls from 10 to 15 feet in 30 to 60 hours, which really renders water navigation out of the question. On high water the drift of logs and other impediments would seriously interfere with water navigation, and we can't see how it would be possible to make use of water navigation to Charlotte Harbor, aside from the fact that we have a rail rate that is much cheaper than it could be barged down.

What we think the proper thing to do would be for the Government to spend all the money that is appropriated for Charlotte Harbor between the long docks at Punta Gorda and Boca Grande. A vessel drawing 12 feet is perhaps the greatest draft any vessel could carry going out of Charlotte Harbor now, when the appropriations properly spent in Charlotte Harbor, or properly spent from the railroad docks to Boca Grande, would admit of vessels drawing much greater depth of water coming right up to the railroad docks at Punta Gorda. This is what the commercial interests in Peace River would like to have, and we hope all the appropriations will be applied in this direction. Any other information that we can render you we will be pleased to furnish it.

Yours, very truly,

ARCADIA PHOSPHATE COMPANY,
Per JOS. HULL,
Secretary and Treasurer.

Capt. W. M. BLACK,
U. S. Engineer.

LETTER OF MR. H. ROBINSON.

THE JACKSONVILLE PEACE RIVER PHOSPHATE COMPANY,
Jacksonville, Fla., December 31, 1890.

DEAR SIR: Our company being largely interested in the commercial interest of Charlotte Harbor and Peace Creek, Florida, and being familiar with the needs of the shipping of the same, is my apology for this letter, and I respectfully request you would give it due consideration.

The appropriation made by Congress for the improvement of Charlotte Harbor and Peace Creek can, in my opinion, be best used for the deepening of the channel between Boca Grande and the railroad wharf at Punta Gorda. Peace Creek proper can not be made navigable north of township 38 without the expenditure of millions of dollars, and if so made would be of little or no value commercially, but, on the contrary, it would be an injury to commerce by displacing the phosphatic deposit in the river. To ship phosphates now (from Punta Gorda, the terminus of the only railroad in that section of country) by water is at present involved with great difficulties, owing to the shallow water in the harbor, and if the appropriation is used for clearing the channel and deepening of it from the mouth of the harbor to the railroad wharf at Punta Gorda, so that steamers drawing 12 to 16 feet of water can load and unload at the wharf, it will be of great benefit to commerce and meet general approbation.

Hoping you will please give this matter favorable consideration, I am, very respectfully, yours truly,

H. ROBINSON,
President of the Jacksonville Peace River Phosphate Company.

Capt. W. M. BLACK,
U. S. Engineer.

O 19.

PRELIMINARY EXAMINATION OF CHARLOTTE HARBOR, FLORIDA.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 12, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of Charlotte Harbor, Florida:

An examination of Charlotte Harbor and Peace Creek was made December 9 to 12, 1890.

Digitized by Google

In a letter dated June 5, 1890, to which I would respectfully refer, and a copy of which is attached, I report that for reasons stated "I would therefore recommend the improvement of the channel to a depth of 15 feet at mean low water."

In the act approved September 19, 1890, an appropriation of $35,000 is made for "improving, dredging, and deepening the channel of Charlotte Harbor and Peace Creek, Florida, to the pier at Punta Gorda, the terminus of the Florida Southern Railroad."

Under this appropriation a survey of the harbor is now being made for the purpose of showing where this money can be expended to the best advantage.

The recent examination has confirmed the report already made as to the commercial needs of the harbor. The supply of phosphates along Peace Creek seems practically inexhaustible, and the development of the mines has but just begun. As stated, the natural outlet for these Peace Creek phosphates is through Charlotte Harbor. On account of the extensive shoals of Charlotte Harbor and the great expense attending its improvement the depth of the channel recommended was limited to 15 feet. This depth will not be sufficient, and it is quite evident that an extension of the present line of railroad from Punta Gorda to the vicinity of the deep-water harbor lying just within Boca Grande Pass is a necessity. It is further unofficially reported that the extension has been practically decided upon. Should this be the case, since under existing conditions practically all the freight seeking the harbor must use this road, the completion of the 15-foot channel through the harbor will be unnecessary, and the improvement of the harbor should be limited to work at the Boca Grande entrance. The present general depth in this pass is 23 feet and over, but it is obstructed by a few shoal spots having over them but 18 feet. These shoals seem quite stable, and it is probable that a dredged channel 23 feet deep could easily be formed and maintained through them.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corp of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., January 17, 1891.

Respectfully submitted to the Chief of Engineers.

This case is peculiar. While "Charlotte Harbor" is mentioned in section 17 of the law of September 19, 1890, as a place for a preliminary examination, an appropriation of $35,000 was made for certain work in "Charlotte Harbor and Peace Creek."

A project for the expenditure of the appropriation was submitted by the local engineer in October, 1890, but I do not know what action was taken upon it by the Chief of Engineers.

The last monthly report of the local engineer refers to a survey of Charlotte Harbor as being in progress.

Under all the circumstances, as stated by the local engineer in his report of January 12, 1891, and in what precedes in this communication,

Digitized by Google

it is my opinion that Charlotte Harbor is worthy of improvement, but the extent can only be decided after the results of the pending survey are known.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

LETTER OF CAPTAIN W. M. BLACK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., June 5, 1890.

GENERAL: I have the honor to submit the following report on the proposed improvement of Charlotte Harbor, Florida, in accordance with Department indorsement dated May 20, 1890:

The distance from the railroad wharf at Punta Gorda to the 24-foot curve of the Gulf of Mexico, measured on the sailing line shown on U. S. Coast and Geodetic Survey chart No. 175, is 27.7 miles. This may be divided as follows, viz: Section 1, from the railroad wharf to buoy No. 8, at the mouth of Pease River, length 2.1 miles, depth 10 to 12 feet; section 2, buoy No. 8 to buoy No. 3, length 11.7 miles, depth 13 to 16 feet; section 3, buoy No. 3 to Boca Grande Pass, length 8.9 miles, depth varies from 11 to 17 feet (this section crosses the shoals south from Cape Haze); section 4, Boca Grande Pass, length 5 miles, depth from 18 to 35 feet. The range of tide in the harbor is 1.14 feet.

The estimated costs of dredged channels 200 feet wide, from the Gulf of Mexico to the wharves at Punta Gorda, as near as can be determined with the limited data available, are as follows, viz:

	Volume of dredging.	Cost.
	Cubic yards.	
13-foot channel	453,154.8	$182,395
14-foot channel	563,480	272,161
15-foot channel	1,300,741	513,258
20-foot channel	18,059,259	8,722,622

With $50,000, a channel 100 feet wide and 13 feet deep can be dredged through section 1, and the remainder could be expended near buoy No. 4, off Cape Haze

These estimates are based on a price of 35 cents per cubic yard for dredging. With liberal appropriations the price per cubic yard would be less and the work accomplished greater. If, as seems probable, the character of the bottom will permit the use of an hydraulic dredge the cost would be lessened by one-third at least.

On January 5, 1887, in accordance with the provisions of the river and harbor act of 1886. I reported that the facilities offered by Charlotte Harbor were sufficient to satisfy all legitimate demands of the existing commerce. Since that time, not only has the general commerce of the harbor increased with the growth of the country, but large and rich deposits of phosphates have been discovered in Pease River, for which the only economical route for shipment is via Charlotte Harbor. Already one 900-ton steamer is regularly engaged in carrying phosphates for one company from Charlotte Harbor to coastwise points. "Their sales for delivery by vessels from Punta Gorda for the remainder of the current year amount to 10,000 tons." The Pease River company expect to ship 60,000 tons during 1891 and it is probable that this amount will increase annually for some time.

At present phosphates are carried by rail to Punta Gorda. There the vessels are loaded to the depth now available and the remainder of the lading is completed at Boca Grande Pass.

As shown above, the numerous shoals of Charlotte Harbor make the volume of dredging necessary for the establishment of a deep channel to the wharves of Punta Gorda very large. Such an increase in the available depth as would permit the regular Gulf and coastwise steamers to touch at the wharves at all stages of the tide would be of great benefit, and its cost would be warranted by the commerce served.

I would therefore recommend the improvement of the channel to a depth of 15 feet at mean low water.

Letters from Messrs. Mason Young, vice president of the Jacksonville, Tampa and Key West, and Florida Southern railroads, M. T. Singleton, engineer and superin-

Digitized by Google

tendent of the Pease River Phosphate Company, and Albert W. Gilchrist, of Punta Gorda, are inclosed.*

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

SUPPLEMENTARY REPORT.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., February 25, 1891.

GENERAL: I have the honor to submit the following report on the survey of Charlotte Harbor, Florida, with projects for its improvement, and a project for expending the remainder of the appropriation of $35,000, made in the act approved September 19, 1890, for "improving, dredging, and deepening the channel of Charlotte Harbor and Pease Creek, Florida, to the pier at Punta Gorda, the terminus of the Florida Southern Railroad."

As stated in the reports on the preliminary examination of Charlotte Harbor, the principal commercial interests to be served by the proposed improvement are those connected with the shipment of phosphate. The phosphate is obtained along the valley of the Pease Creek, and is brought by rail to the terminus of the Florida Southern Railway at Punta Gorda. From there it is lightered to vessels lying in the deep-water anchorage just within the Boca Grande entrance of Charlotte Harbor. At times a portion of the lading of the vessels is made at Punta Gorda and the remainder at the anchorage. The present low-water depth to the wharf at Punta Gorda is 9 feet.

As immediate relief is desired, I would recommend that the appropriation available be expended in opening a 12-foot channel across all the shoals between the Boca Grande entrance and Punta Gorda. The width of the channel will depend on the price asked for the dredging, but the estimates show that the amount available will be sufficient to make a channel with a least width of from 50 to 60 feet. A continuous depth greater than 12 feet can not be obtained under this appropriation. To enable vessels to follow the channel it should be marked plainly by clusters of piles. The estimated cost of the work is as follows:

Cost of survey	$2,000
Dredging	29,300
Marking channel	200
Engineering, superintendence, and contingencies	3,500
Total	35,000

On account of the extensive shoals of the harbor, the formation of a deep dredged channel from Boca Grande to Punta Gorda would be very expensive. Such a channel would require constant attention and annual dredging. The least channel depth which would afford any great relief to commerce is 15 feet, and the cut should be at least 200 feet wide. The estimated cost is as follows:

Dredging 1,417,000 cubic yards, at 30 cents per yard	$425,100
Marking channel	360
Engineering and contingencies	42,540
Total	468,000

* Not submitted.

Digitized by Google

Digitized by Google

Digitized by Google

Shipments can not be made to foreign ports with economy in vessels drawing less than 18 feet of water. This depth can now be carried through the Boca Grande entrance. The extension of the railway to the Boca Grande anchorage would seem to be economic necessity, and it is unofficially reported that this extension is to be made. In this case any further improvement of the interior channels of the harbor is entirely unnecessary. By the removal of a few shoals, the Boca Grande entrance can be deepened to 23 feet. The stable character of this entrance and of the other bars of the entrances on the west coast of the Florida Peninsula makes it probable that dredged cuts across them would have a fair degree of permanence and could be maintained with but a small annual outlay.

Should a railroad then be extended to the Boca Grande anchorage, I would recommend that the improvement of the harbor be restricted to work at the entrance.

The estimated cost of dredging a channel 300 feet wide and 23 feet deep from the Gulf of Mexico to the anchorage within the Boca Grande entrance is as follows:

For dredging 107,000 cubic yards, at 30 cents per yard	$32,100
Engineering, superintendence, and contingencies	3,200
Total	35,300

These estimates are based upon the results of the recent survey of the harbor. The cost of dredging will be increased by small appropriations. An outline tracing showing the position of the proposed cuts is forwarded herewith.

Very respectfully, your obedient servant,

W. M. BLACK,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Wm. P. Craighill, Corps of Engineers, Division Engineer, Southeast Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Baltimore, Md., February 28, 1891.

Respectfully submitted to the Chief of Engineers, and recommended for favorable consideration.

WM. P. CRAIGHILL,
Colonel, Corps of Engineers.

O 20.

ESTABLISHMENT OF HARBOR LINES IN ST. AUGUSTINE HARBOR, FLORIDA.

ST. AUGUSTINE, FLA., *July 11, 1889.*

SIR: By a resolution adopted by this body at a regular meeting held on the 11th day of July, 1889, it was resolved that the honorable Secretary of War be petitioned by this body, representing the citizens of the said city of St. Augustine, for permission to fill in and utilize for city purposes the spaces in Bay street of said city projecting westwardly from the sea wall and commonly designated as the "basins."

Digitized by Google

Therefore, in pursuance to said resolution, we would respectfully call your attention to the fact that said "basins," form very awkward obstructions in the principal street of our city, causing the said street to deviate in its course, to the material inconvenience of the traveling public; and as our city is undergoing a period of substantial and permanent progression, and the commerce of the city is largely increasing every year, it is absolutely necessary that our narrow streets should have every obstruction and impediment removed, thereby affording our steadily increasing population the full and uninterrupted use of our streets and highways.

We would also call your attention to the fact that said basins are receptacles of filth and garbage, and consequently are seriously detrimental to the health of our city, and are of very little practical use to any class of our citizens, and of no use or benefit to the military or naval forces of the Government.

Therefore, in consideration of the foregoing facts, we would respectfully ask that this council be granted permission to fill in said basins, thereby straightening and improving our city front, and also abating a serious nuisance and menace to the sanitary condition of our city.

[SEAL.] JOHN P. WHITNEY,
President of Board of Aldermen.

Attest:

J. A. USINA,
City Clerk.

To the honorable SECRETARY OF WAR.

As mayor of the city of St. Augustine I approve the above action of the council, but would ask that, should the request be granted, it be stipulated that the space so filled in be utilized for public park and street purposes only.

W. S. M. PINKHAM,
Mayor.

* * * * * * *

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 21, 1889.

Respectfully referred to Capt. W. M. Black, Corps of Engineers, for investigation and report. * * *

By command of Brigadier-General Casey:

CLINTON B. SEARS,
Captain, Corps of Engineers.

[Sixth indorsement.]

U. S. ENGINEER OFFICE,
St. Augustine, Fla., November 20, 1889.

Respectfully returned to the Chief of Engineers, U. S. Army.

* * * * * * *

It is essential for the preservation and protection of the harbor that pier and bulkhead lines should be established in the manner prescribed in section 12 of the river and harbor act of August 11, 1888.

* * * * * * *

W. M. BLACK,
Captain, Corps of Engineers.

Digitized by Google

[Seventh indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 14, 1889.

Respectfully returned to the Secretary of War.

* * * * * * *

Capt. W. M. Black, Corps of Engineers, the officer in charge of the fort at St. Augustine, to whom this paper was referred, reports * * * that it is essential for the preservation of the harbor that pier and bulkhead lines be established.

* * * * * * *

I would further recommend that a Board of officers of the Corps of Engineers, to consist of Capt. W. M. Black, First Lieut. O. M. Carter, First Lieut. D. DuB. Gaillard, be constituted, under section 12 of the river and harbor act of August 11, 1888, to meet at St. Augustine, Fla., at as early a day as practicable, to establish harbor lines for this harbor.

If this be approved, the necessary orders can be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

* * * * * * *

[Tenth indorsement.]

WAR DEPARTMENT, *January 6, 1890.*

Respectfully returned to the Chief of Engineers.

* * * * * * *

The recommendation of the Chief of Engineers for the appointment of a Board to establish harbor lines is approved.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Augustine, Fla., January 26, 1891.

Proceedings and report of Board of Engineers convened by the following special order:

HEADQUARTERS, CORPS OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 8, 1890.

SPECIAL ORDERS No. 3.

By direction of the Secretary of War, a board of officers of the Corps of Engineers, to consist of Capt. William M. Black, First Lieut. Oberlin M. Carter, First Lieut. David DuB. Gaillard, will convene at St. Augustine, Fla., at as early a day as practicable, upon the call of the senior member, to establish the harbor lines in St. Augustine Harbor, Florida, in accordance with section 12 of the river and harbor act of August 11, 1888.

Upon completion of the duties assigned them the members of the Board will return to their proper stations.

The journeys required under this order are necessary for the public service.

By command of Brigadier-General Casey:

CLINTON B. SEARS,
Captain, Corps of Engineers.

Digitized by Google

The Board met in pursuance of the above order on January 24, 1890, and after inspecting all maps and papers relating to the subject deemed the data on hand insufficient and ordered a survey to be made comprising the St. Sebastian River and the marshes surrounding the city.

Owing to sickness in the office force, this survey was not completed until late in June.

It was then deemed best to postpone the next meeting of the Board until winter, owing to the absence during the summer of the largest property-owners of St. Augustine.

The Board met again on January 19, 1891, at which meeting all citizens interested in the location of harbor lines were invited to appear and present their views.

In response to this invitation a number of persons appeared at the meeting of the Board.

The Board, having conferred with the persons present and having examined the harbor and the data relating thereto, has the honor to submit the following report:

The Board finds that no harbor or port-warden lines are established here and that there is nothing to define the extent of the harbor. The board has therefore adopted the limits shown on the accompanying blue print.

The Board deems it necessary to establish two lines, the pier-head line being one, beyond which no pile structure shall extend, and the bulkhead line, one beyond which no solid filling shall be permitted.

Computations show that should the entire shore line of the harbor be filled solidly out to the bulkhead line the tidal prism would be reduced only about 2 per cent.

As the channel of the St. Sebastian River is kept open almost entirely by the aid of the tidal basin lying north of the railroad bridge, the bulkhead line has been there located so as not to diminish this tidal prism appreciably.

Should future improvements give deep water on the bar, all heavy shipping must of necessity find harbor in the North River, owing to insufficient depth in front of the city.

Both the pier and bulkhead lines proposed are shown on the accompanying blue print* and the bulkhead line is in addition described in the accompanying paper.

The Board then adjourned *sine die*.

Respectfully submitted.

W. M. BLACK,
Captain, Corps of Engineers.
O. M. CARTER,
First Lieut., Corps of Engineers.
D. D. GAILLARD,
First Lieut., Corps of Engineers.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 18, 1891.

Respectfully submitted to the Secretary of War.

It having become manifest to the Secretary of War that the establishment of harbor lines was essential to the preservation and protec-

* Omitted.

Digitized by Google

tion of St. Augustine Harbor, Florida, a Board of Engineers was, by his direction, constituted by Special Orders No. 3, Headquarters, Corps of Engineers, January 8, 1890, to consider and report upon the subject of such harbor lines in accordance with the provisions of the river and harbor act of August 11, 1888.

In compliance with this order the said Board of Engineers now submits a report, dated January 26, 1891, recommending for the approval of the Secretary of War the harbor lines described in the within report and accompanying paper and delineated upon the inclosed chart, viz: (1) West side of North Beach. (2) St. Anastasia Island. (3) St. Augustine, east side, and San Sebastian River. (4) Island in San Sebastian River, WNW. from San Marcos Hotel.

It is recommended that the lines selected be approved and that the Secretary place his approval both upon the report and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT, *February 20, 1891.*

Approved as recommended by the Chief of Engineers.

REDFIELD PROCTOR,
Secretary of War.

LOCATION OF PIER AND BULKHEAD LINES, HARBOR OF ST. AUGUSTINE, FLORIDA, AS RECOMMENDED BY BOARD OF ENGINEERS CONVENED BY SPECIAL ORDERS NO. 3, DATED HEADQUARTERS CORPS OF ENGINEERS, U. S. ARMY, WASHINGTON, D. C., JANUARY 8, 1890, TO ACCOMPANY THE MAP OF THE HARBOR SUBMITTED WITH THE REPORT OF THE BOARD DATED JANUARY 26, 1891.

The bulkhead line is shown thus: ——————————

The pierhead line is shown thus: — — — — —

The pier lines may be located at any point by measurements from the bulkhead line.

The bulkhead line may be located by reference to the following triangulation stations of the survey of St. Augustine Harbor of 1887:

North Point (near southern end of North Beach).
St. Augustine Light-House (St. Anastasia Island).
Shell Bank (western shore of St. Anastasia Island).
San Marco Hotel (flagstaff on central tower).
Fort Marion (northeast tower).
St. Francis Barracks (see notes of survey).

The bearings refer to the true meridian. The magnetic variation in 1887 was 2° 21′ east.

DESCRIPTION OF BULKHEAD LINES.

1. West side of North Beach.—Commencing at a point on groin No. 2 (south end of North Beach) distant 800 feet from North Point, thence N. 56° 5′ W. a distance of 420 feet, thence N. 31° 50′ W. a distance of 2,880 feet, thence N. 17° 30′ W. a distance of 2,584 feet, thence N. 10° 50′ W. a distance of 1,870 feet to a point on the west shore line of North Beach, from which point North Point bears S. 26° 10′ E. and San Marcos Hotel bears S. 33° 45′ W.

2. St. Anastasia Island, commencing at a point on groin No. 1 (east side of island) distant 180 feet out from shore end of groin; thence N. 48° 30′ W., a distance of 1,380 feet; thence N. 39° 35′ W., a distance of 870 feet; thence N. 32° 7′ W., a distance of 2,185 feet; thence around the north end of the island on a circular arc (of 1,360 feet radius), from whose center North Point bears N. 62° E. and light-house bears S. 42° 30′ E., to a point in line with Fort Marion and said center; thence S. 9° 8′ W., a distance of 515 feet; thence S. 4° 38′ E., a distance of 650 feet; thence S. 15° 5′ E., a distance of 1,475 feet; thence S. 51° 30′ E., a distance of 1,445 feet; thence S. 23° 40′ E., a distance of 1,040 feet, to a point at the mouth of Quarry Creek, from which light-house bears N. 88° 38′ E. and Shell Bank bears S. 7° 30′ W.; thence (up Quarry Creek) S. 45°

Digitized by Google

30′ E., a distance of 1,520 feet; thence S. 30° 5′ E., a distance of 860 feet; thence S. 65° 36′ E., a distance of 490 feet; thence S. 45° 32′ E., a distance of 250 feet; thence 126° around a circular arc (of 330 feet radius) from whose center light-house bears N. 23° 33′ E. and barracks bears N. 58° 40′ W., to a point in line with barracks and said center; returning on opposite shore of Quarry Creek, commencing at a point in line with barracks and center last located, 55 feet from point last located; thence 126° around a circular arc (of 275 feet radius) described from said center; thence N. 60° W., a distance of 300 feet; thence N. 78° 40′ W., a distance of 260 feet; thence N. 58° W., a distance of 310 feet; thence N. 34° 16′ W., a distance of 1,010 feet; thence N. 50° 30′ W., a distance of 1,010 feet to a point at the mouth of Quarry Creek, from which light-house bears N. 81° 50′ E. and Shell Bank bears S. 8° 50′ W.; thence S. 22° 45′ W., a distance of 480 feet; thence S. 1° E., a distance of 1,580 feet; thence S. 21° W., a distance of 800 feet to Shell Bank; thence S. 16° 50′ W., a distance of 825 feet; thence S. 29° 54′ W., a distance of 1,650 feet; thence S. 16° 45′ W., a distance of 2,700 feet.

3. St. Augustine, east side, and San Sebastian River, commencing on the shore north of Comache Creek on west shore of North River at a point from which North Point bears S. 40° 20′ E. and San Marcos Hotel bears S. 22° 20′ W.; thence S. 18° E., a distance of 3,400 feet; thence S. 62° 15′ W., a distance of 1,340 feet; thence S. 79° 52′ W., a distance of 1,100 feet, to a point on north shore of Hospital Creek; thence along said shore following line of marsh as shown on map; returning along opposite shore of creek as shown on map to a point at the mouth of the creek from which North Point bears S. 73° 35′ E. and San Marcos Hotel bears S. 38° 5′ W.; thence S. 5° W., a distance of 150 feet; thence S. 35° 20′ W., a distance of 960 feet; thence S. 22° 15′ W., a distance of 870 feet; thence S. 4° 30′ W., a distance of 1,200 feet to a point on water battery of Fort Marion in line with NE. tower of Fort Marion and point last located; thence along face of said battery and connecting sea wall to southern extremity of sea wall (from which point barracks bears N. 40° 35′ W., a distance of 470 feet); thence S. 27° 53′ E., a distance of 1,636 feet; thence S. 17° 45′ E. a distance of 1,737 feet; thence S. 6° 10′ E. a distance of 1,025 feet to a point from which barracks bears N. 20° 45′ W. and Shell Bank bears N. 73° 5′ E.; thence S. 21° 35′ W., a distance of 2,075 feet; thence 88° 25′ around a tangential circular arc (of 150 feet radius) at the mouth of the San Sebastian River; thence (up said river) tangentially N. 70° W., a distance of 1,870 feet; thence N. 89° W., a distance of 750 feet, to a point from which Shell Bank bears N. 69° 50′ E. and San Marcos Hotel bears N. 40′ E.; thence N. 21° 10′ W., a distance of 380 feet; thence N. 1° 35′ W., a distance of 420 feet; thence N. 13° 15′ E., a distance of 1,745 feet; thence 79° 10′ around a tangential circular arc (of 450 feet radius), from whose center Shell Bank bears S. 80° 40′ E. and Fort Marion bears N. 12° 37′ E.; thence tangentially N. 65° 55′ W., a distance of 970 feet; thence N. 84° 5′ W., a distance of 410 feet; thence S. 88° 15′ W., a distance of 490 feet; thence N. 65° 45′ W., a distance of 530 feet; thence 123° 30′ around a tangential circular arc (of 580 feet radius) from whose center Shell Bank bears S. 70° 30′ E. and Fort Marion bears N. 32° E.; thence tangentially N. 59° 45′ E., a distance of 1,240 feet; thence 90° around a tangential circular arc (of 420 feet radius); thence tangentially N. 32° 15′ W., a distance of 185 feet; thence 60° around a circular arc (of 370 feet radius) from whose center Shell Bank bears S. 55° 15′ E. and Fort Marion bears N. 40° 22′ E.; thence tangentially N. 41° 10′ W., a distance of 250 feet; thence 53° 35′ around a tangential circular arc (of 370 feet radius); thence N. 55° W., a distance of 290 feet; thence S. 82° 45′ W., a distance of 130 feet; thence N. 12° 20′ W., a distance of 245 feet; thence N. 82° 45′ E. a distance of 130 feet; thence N. 12° 20′ W., a distance of 660 feet; thence 29° around a tangential circular arc (of 1,300 feet radius), from whose center Shell Bank bears S. 42° 30′ E. and Fort Marion bears N. 55° 40′ E.; thence tangentially N. 16° 40′ E., a distance of 916 feet; thence due north a distance of 700 feet; thence N. 7° 22′ W., a distance of 1,100 feet; thence N. 2° 40′ E., a distance of 860 feet; thence N. 7° 10′ W., a distance of 1,196 feet; thence N. 13° 45′ W., a distance of 1,080 feet; thence N. 26° 15′ W., a distance of 1,564 feet; thence 60° around a tangential circular arc (of 460 feet radius) to intersection of shore line and south side of bridge; returning along the opposite shore of San Sebastian River, commencing at intersection of south side of bridge and inner marsh line (from which point San Marcos Hotel bears S. 42° 50′ E.) thence S. 6° E., a distance of 310 feet; thence 79° 45′ around a tangential circular arc (of 360 feet radius); thence tangentially 41° 30′ around a reverse circular arc of same radius; thence tangentially S. 44° 15′ E., a distance of 780 feet; thence S. 18° 50′ W., a distance of 1,130 feet; thence 45° 15′ around a tangential circular arc (of 910 feet radius); thence tangentially 159° 30′ around a reverse circular arc (of 230 feet radius); thence 55° 45′ around circular arc (from whose center the point last located bears N. 57° 45′ E., a distance of 600 feet); thence tangentially 74° 30′ around a reverse circular arc (of 600 feet radius); thence tangentially 47° around a reverse circular arc (of 910 feet radius); thence tangentially S. 2° 45′ E., a distance of 560 feet; thence around a circular arc (of 940 feet radius) to a point bearing S. 2° 45′ E., a distance of 950 feet from point last located; thence S. 2° 45′ E., a distance of 520 feet to a point from which Fort Marion bears N. 67° 30′ E.

Digitized by Google

and Shell Bank bears S. 55° 20′ E.; thence N. 38° E. a distance of 380 feet; thence 127° 54′ around a tangential circular arc (of 100 feet radius); thence tangentially S. 14° 6′ E., a distance of 237 feet; thence 95° 34′ around a tangential circular arc (of 200 feet radius); thence tangentially N. 70° 20′ E., a distance of 125 feet; thence 99° 40′ around a tangential circular arc (of 100 feet radius); thence tangentially S. 10° E., a distance of 890 feet; thence S. 46° 22′ E., a distance of 815 feet; thence 84° 2′ around a tangential circular arc (of 200 feet radius); thence tangentially S. 37° 40′ W., a distance of 970 feet; thence 112° around a tangential circular arc (of 200 feet radius) from whose center Fort Marion bears N. 40° 35′ E. and Shell Bank bears S. 65° 20′ E.; thence tangentially and up creek along marsh line, returning along south shore of creek to a point S. 22° W., a distance of 150 feet from the point at end of arc last located on opposite shore of creek; thence 62° around a tangential circular arc (of 200 feet radius); thence tangentially 91° 30′ around a reverse circular arc (of 840 feet radius), from whose center Fort Marion bears N. 31° 30′ E. and Shell Bank bears S. 70° 30′ E.; thence tangentially S. 57° 35′ E., a distance of 500 feet; thence S. 63° 37′ E., a distance of 700 feet; thence S. 87° 20′ E., a distance of 965 feet; thence S. 74° 20′ E., a distance of 310 feet; thence 107° 20′ around a tangential circular arc (of 200 feet radius), from whose center Fort Marion bears N. 12° 30′ E. and Shell Bank bears S. 81° 15′ E.; thence tangentially S. 33° W., a distance of 360 feet; thence S. 22° W., a distance of 510 feet; thence S. 4° 55′ W., a distance of 760 feet; thence 70° around a tangential circular arc (of 380 feet radius), from whose center Fort Marion bears N. 14° 37′ E. and Shell Bank bears N. 81° 35′ E., thence tangentially and up creek along marsh line, returning on south side of creek to a point from which center last located bears N. 15° 5′ W., a distance of 430 feet; thence N. 74° 55′ E., a distance of 260 feet; thence 120° around a tangential circular arc (of 100 feet radius); thence tangentially 104° 45′ around a reverse circular arc (of 650 feet radius), from whose center Fort Marion bears N. 7° 5′ E. and Shell Bank bears N. 72° E.; thence tangentially S. 89° 50′ E., a distance of 550 feet; thence S. 61° E., a distance of 1,525 feet; thence 77° around a tangential circular arc at the mouth of San Sebastian River (of 300 feet radius), from whose center San Marcos Hotel bears N. 9° 27′ W. and light-house bears N. 45° 35′ E.

4. Island in San Sebastian River, WNW. from San Marcos Hotel, commencing at a point at the southern end of the island, from which point North Point bears N. 86° 7′ E. and Shell Bank bears S. 43° 20′ E.; thence N. 21° 30′ E., a distance of 1,000 feet; thence 122° around a tangential circular arc (of 383 feet radius); thence tangentially S. 79° 30′ W., a distance of 350 feet; thence S. 54° 30′ W., a distance of 290 feet; thence S. 31° 15′ E., a distance of 715 feet; thence S. 24° E., a distance of 660 feet to the point of beginning at the southern end of the island.

W. M. BLACK,
Captain, Corps of Engineers.
O. M. CARTER,
First Lieutenant, Corps of Engineers.
D. D. GAILLARD,
First Lieutenant of Engineers.

Digitized by Google

Digitized by Google

APPENDIX P.

IMPROVEMENT OF CERTAIN RIVERS IN GEORGIA, FLORIDA, AND ALABAMA, AND OF APALACHICOLA BAY AND HARBOR AT PENSACOLA, FLORIDA.

REPORT OF CAPTAIN PHILIP M. PRICE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Apalachicola Bay, Florida.
2. Apalachicola River, Florida, including Lee Slough.
3. Flint River, Georgia.
4. Chattahoochee River, Georgia and Alabama.
5. La Grange Bayou and Holmes River, Florida.
6. Choctawhatchee River, Florida and Alabama.
7. Harbor at Pensacola, Florida.
8. Escambia and Conecuh rivers, Florida and Alabama.
9. Alabama River, Alabama.
10. Tallapoosa River, Alabama.
11. Coosa River, Georgia and Alabama.
12. Operating and care of canals and other works of navigation on Coosa River, Georgia and Alabama.
13. Cahaba River, Alabama.

EXAMINATIONS.

14. Chattahoochee River, Georgia and Alabama, between West Point and Franklin.
15. Alabama River, Alabama, to ascertain cost of securing a 6-foot channel at low water, from mouth to Wetumpka.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., July 10, 1891.

GENERAL: I have the honor to forward herewith annual reports in duplicate for the fiscal year ending June 30, 1891, upon the works under my charge.

* * * * * * *

Very respectfully, your obedient servant,

PHILIP M. PRICE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Digitized by Google

P 1.

IMPROVEMENT OF APALACHICOLA BAY, FLORIDA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved July 11, 1870, an examination and partial survey at the mouth of Apalachicola River, with a view to its improvement, was made in 1871, and a further examination was made in 1879, for the purpose of ascertaining the changes which had taken place since 1871. The minimum depth of water over the bar at the mouth of the river was 3½ feet.

These examinations resulted in the adoption of a plan of improvement which contemplated the dredging of a straight channel through the bar at the mouth of the river to a depth of 11 feet and a width of 100 feet, to be afterwards increased to 200 feet if the first cut should produce results that would warrant it. During the progress of the work it has been urged that sufficient appropriations should be made to complete the cut through the bar. It was thought that a continuous dredged channel of the approved width and depth might be to some extent self-sustaining, but funds have never been available for dredging the channel called for by the approved project.

The original estimate of the cost of the improvement was $100,000. Dredging has been done from time to time, as funds have been available, since 1881, but on account of the limited appropriations the dredged cut has never exceeded 90 feet in width and 9½ feet in depth. The last dredging was completed on May 10, 1890, at which time the dredged channel had a depth of 8 feet at mean low water, and a maximum width of 90 feet.

APPROPRIATIONS.

June 14, 1880	$10,000	August 11, 1888	$20,000
March 3, 1881	10,000	September 19, 1890	20,000
August 2, 1882	25,000		
July 5, 1884	10,000	Total	107,000
August 5, 1886	12,000		

WORK DONE DURING THE PAST FISCAL YEAR.

In accordance with the approved project, a survey of the mouth of the Apalachicola River and of a portion of Apalachicola Bay was begun in February, 1891, by Assistant Engineer Thomas Robinson. His report was submitted on May 5, 1891, and forwarded to the Chief of Engineers with my report of May 15, 1891.

This survey shows that the dredged channel has shoaled 2 feet on its outer half, and 1 foot on the inner portion. The Bulkhead Shoal—on which there is but 6 feet of water—now forms the most serious obstruction to the commerce of Apalachicola Bay, and in the above-mentioned report I recommended the expenditure of the available funds in dredging a channel through this shoal to a depth of 9 feet, and to as great a width—not exceeding 100 feet—as is practicable.

The trade of Apalachicola consists mainly of the exportation of lumber. The ships usually enter by the East Pass, and lie near the entrance, and the lumber, with which they are to be loaded, is towed in rafts from the mills in the river by tugs drawing 4 or 5 feet. With a 9-foot channel through Bulkhead Shoal, vessels can be brought several miles nearer the mills for partial loading.

Digitized by Google

My recommendation for the dredging of a channel through Bulkhead Shoal having been approved by the Chief of Engineers on May 20, 1891, proposals for doing the work were requested by an advertisement dated June 10, 1891. The proposals are to be opened on July 15, 1891. If reasonable bids are received in answer to the advertisement, it is proposed to expend the entire sum now available in dredging.

RECOMMENDATIONS.

At the present rate of shoaling of the dredged cut through the bar at the mouth of the river, it is anticipated that by next year it will be necessary to redredge this channel. If this is not done, it is probable that its navigation by the tugs, now employed in carrying on the business of the port, will be very much impeded, if not entirely stopped.

The estimated cost of dredging a channel of the approved depth of 11 feet, and width of 100 feet, is $60,000, and to do the work economically, the whole amount should be appropriated at one time.

Money statement.

July 1, 1890, balance unexpended	$1,990.62
Amount appropriated by act approved September 19, 1890	20,000.00
	21,990.62
June 30, 1891, amount expended during fiscal year	3,529.38
July 1, 1891, balance unexpended	18,461.24
July 1, 1891, outstanding liabilities	3.50
July 1, 1891, balance available	18,457.74
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	60,000.00

COMMERCIAL STATISTICS FOR APALACHICOLA BAY, FLORIDA.

Statement of the commerce of the port of Apalachicola, Fla., from July 1, 1890, to June 30 1891, inclusive.

Custom-house receipts; from all sources:		
Duties on imports		$361.38
Tonnage duties		633.99
Miscellaneous custom receipts		15.00
Official fees		248.33
Total		1,258.70
Number of vessels entered, 79	tons	34,428
Number of vessels cleared, 83	do	38,634
Number of vessels employed in the traffic of Apalachicola Bay		86
Number of superficial feet of timber and lumber exported		30,330,933
Estimated number of vessels and river steamers arrived and departed		670
Estimated tonnage of above vessels		85,000
Value of exports to foreign ports		122,359
Value of exports to coastwise ports		340,000
Total value of exports		462,359
Value of imports from foreign ports		1,247
Value of imports from coastwise ports		27,000
Total value of imports		28,247
Total value of imports and exports		490,606
Estimated value of exports to coastwise ports by sail vessels and river steamers, which do not enter or clear from the custom-house		625,000
Estimated value of imports to coastwise ports by sail vessels and river steamers, which do not enter or clear from the custom-house		950,000

Digitized by Google

There are four sawmills which can turn out 240,000 superficial feet of lumber per day; one shingle mill with a capacity of 150,000 shingles per day; two oyster canning factories, with a capacity of 40,000 cans per day, and two more canning (oyster) factories in the process of erection, to be ready for next winter's packing, with same capacity; one fish-packing establishment, which packs about 5,000 barrels of salted and pickled fish per annum; one ice factory, 7 tons per day.

All the above enterprises expect to do double the amount of business for the next year, as the demand for all the above-mentioned products is unlimited.

A. J. MURAT,
Special Deputy Collector of Customs.

P 2.

IMPROVEMENT OF APALACHICOLA RIVER, FLORIDA, INCLUDING LEE SLOUGH, FLORIDA.

PLAN OF IMPROVEMENT.

A survey for the improvement of the Apalachicola River was made in 1872 and 1873, and resulted in the adoption of a project which contemplated securing a channel 100 feet wide and 6 feet deep, at low water, by the removal of snags and overhanging trees and widening and straightening Moccasin Slough and the Elbows, at an estimated cost of $60,333.

The act of August 11, 1888, directed an examination of the "Chipola River, from its mouth to Wewahitchka, and the 'cut-off,' and 'Lee Slough,' running from the Apalachicola River to the Chipola River."

This examination was made in 1889, and resulted in the recommendation that a channel 60 feet wide and 5 feet deep should be cleared through the cut-off, Lee Slough and the Lower Chipola River, at an estimated cost of $7,500.

The act of September 19, 1890, appropriated $2,000 for maintaining the existing works on the Apalachicola River, including Lee Slough.

The present approved project, therefore, provides for securing a channel 100 feet wide and 6 feet deep, at low water, in the Apalachicola River by the removal of snags and overhanging trees, and widening and straightening Moccasin Slough and the Elbows, and for securing a channel through Lee Slough 60 feet wide and 5 feet deep, at low water, by the removal of logs and snags, and overhanging trees.

APPROPRIATIONS.

June 23, 1874	$10,000	July 5, 1884	$1,000
March 3, 1875	10,000	August 5, 1886	1,000
June 18, 1878	8,000	August 11, 1888	2,000
March 3, 1879	5,000	September 19, 1890	2,000
June 14, 1880	2,000		
March 3, 1881	1,500	Total	44,500
August 2, 1882	2,000		

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has been $2,472.22. This amount has only sufficed for the annual clearing out of the logs and snags brought into the river by the winter freshets of the Chattahoochee and Flint Rivers, and for an imperfect improvement of the river at Moccasin Slough.

Digitized by Google

Digitized by Google

STEAMERS RUN FROM (A) TO (B) AND

ALSO FROM (D) TO (C) AND

SHADED PORTION, LEE'S SLOUGH, IS CLEAR F

(3) INDICATES MILES.

Photo-Lith. by A. HOEN & CO., Balto., Md.

Digitized by Google

The original cut at Moccasin Slough was made narrow and shallow, with the expectation that the stream itself would widen and deepen it; but the bottom and banks, which consist of heavy clay, do not readily yield to the action of the current, and further excavation is necessary to make navigation safe.

The appropriations of late years have not been sufficient to do this work.

There is no plant on this river, and the annual snagging work is done by the Chattahoochee River snagboat at times when the water in the latter river is too high for channel work.

The river is now in fairly good navigable condition except at Moccasin Slough and the Elbows.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, in local charge of this improvement, reports as follows:

In the last river and harbor bill "Lee Slough" was included in this improvement, and as therein used the term "Lee Slough" was evidently meant to include the whole water way, consisting of the Cut-off, "Lee Slough," and the Lower Chipola River, extending from the Apalachicola River, near Iola, Fla., around by Wewahitchka and down the Chipola River to the Apalachicola River below. With this interpretation of the law, work has been done in the Lower Chipola River (immediately below Lee Slough) and in the Cut-off above the "Slough." No work was done in the Slough itself, for the whole appropriation, if expended extirely upon the Slough, would not have sufficed to open a channel more than one-third the length of it; and it was deemed better for all parties interested to confine the work of clearance of channel to those portions of this water way that were practical for the use of steamboats than to expend the money in a hole in the swamp that would be utterly useless unless a channel were opened completely through it. An outline survey of this water way has been made by Mr. D. S. McClain—map herewith submitted—and it does not appear that the original estimate of cost of this improvement will be at all, or much, changed, and the old figures of cost are again submitted.

No special plant is asked for on this river, since it will be economy to employ the snag boat *Chattahoochee*, when otherwise it might be laid up idle during the winter months in the Chattahoochee River.

WORK DONE.

In April, 1891, as soon as the repairs to the *Chattahoochee* were completed, the boat was started to work at Apalachicola, Fla. In a month and a half, with an average crew of 14 men, 3 old piles, 558 snags and logs, 21 stumps, and 2,142 overhanging trees and 675 bushes were removed from the channel and river banks of the Apalachiola River, and the upper part of Lee Slough, generally known as the "Cut-off."

RECOMMENDATIONS AND ESTIMATES.

The map herewith shows the condition of affairs at Lee Slough.

It is understood that the wording of the act of September 19, 1890, requiring the improvement of Lee Slough, includes that of the Cut-off and the lower Chipola River, as there is no other way of reaching Lee Slough except to clear out the Cut-off and the lower Chipola River, which give access to it.

During the past spring the Chattahoochee River snag boat did enough work in the Cut-off and Chipola River to enable steamboats to reach the landings above and below Lee Slough and carry out the orange crop.

Lee Slough itself is so blocked with logs, snags, and overhanging timber that at least $7,500 will be required to make a channel through it.

This should be done, in order that the river steamers may enter the

Digitized by Google

Cut-off, pass through Lee Slough, and return to the Apalachicola River through the lower Chipola River.

The country bordering on this slough is now attracting settlers, and would be rapidly developed were easy means provided for the transportation of their products to market. Their only means of transportation is by river, and I therefore urgently recommend that the sum of $7,500 be appropriated for this work.

It is estimated that the improvement needed at Moccasin Slough and the Elbows will cost $5,000, and that the necessary snagging operations to maintain the existing improvement will cost $2,000.

The sum of $14,500 can therefore be profitably expended during the fiscal year ending June 30, 1893.

Money statement.

July 1, 1890, balance unexpended	$320.79
Amount appropriated by act approved September 19, 1890	2,000.00
	2,320.79
June 30, 1891, amount expended during fiscal year	1,566.32
July 1, 1891, balance unexpended	754.47
July 1, 1891, outstanding liabilities	4.85
July 1, 1891, balance available	749.62
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	14,500.00

COMMERCIAL STATISTICS FOR APALACHICOLA RIVER, FLORIDA.

All of the eight steamboats which run on the Chattahoochee River also run on this river, their regular trips being made between Columbus, Ga., and Apalachicola, Fla., at the mouth of the Apalachicola River.

It is not possible to state the amount of business done on the Apalachicola River separately from that done on the Chattahoochee River, but in general terms it may be stated that it is the same.

Reference is therefore made to the report on the Chattahoochee River for commercial statistics.

P 3.

IMPROVEMENT OF FLINT RIVER, GEORGIA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 10, 1872, an examination and partial survey of this river was made in 1872 and 1873, and under an act approved June 18, 1878, a further examination was made in 1879.

The plan of improvement adopted pursuant to these examinations provides for a low-water navigable channel 3 feet deep and 100 feet wide from the mouth of the river to Albany, Ga., an estimated distance of 105 miles; and a navigable channel for light-draft steamers at moderate stages of water from Albany to Montezuma, Ga., an estimated distance of 77 miles, to be secured by the removal of snags and over-

Digitized by Google

hanging trees, scouring bars by works of contraction, and cutting through the rock reefs.

For the lower river the work is principally upon the rock bottom of the river, and is of a permanent character. In the upper river, between Albany and Montezuma, there will be a considerable accumulation of snags to be removed.

APPROPRIATIONS.

June 18, 1878	$10,000	August 5, 1886	$20,000
March 3, 1879	7,000	August 11, 1888	20,000
June 14, 1880	20,000	September 19, 1890	20,000
March 3, 1881	15,000		
August 2, 1882	25,000	Total	157,000
July 5, 1884	20,000		

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $11,214.28. With this amount a moderately efficient working plant has been maintained upon the river for rock excavation below Albany, Ga., and for snagging operations between Albany and Montezuma, Ga. A navigable channel having the proposed depth at low water and a width varying from 50 to 100 feet has been excavated from the mouth of the river nearly to Albany.

The contemplated width can not be given at all points without risk of lowering too greatly the low-water surface of the river. Above Albany the river has been partially cleared of logs and snags, and to a limited extent of loose rock in the channel between Albany and Montezuma.

The work of rock excavation on the shoals of this river, progressing upwards from the mouth, must be expected to lower to some extent the plane of low water and to develop rock obstructions not included in the original estimate. This cumulative effect appears in the short section of the river between Blue Springs and Albany, where a much larger amount of work is required than was contemplated in the original estimate.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, in local charge of the improvement, reports as follows:

During the season of 1890, from lack of funds, no work was done, and the working plant remained in care of a watchman.

In May, 1891, a fantail platform, tool locker and new derrick boom were made for the snag boat, and a working frame and tool locker for the drilling barge, and a large skiff was built to work with the latter.

The boats thus equipped were set to work. The snag boat *Flint*, working up towards Montezuma, removed 236 snags and logs and 12 cubic yards loose rocks from the channel, and 21 stumps and logs and 234 overhanging trees from the banks. The drilling barge removed 415 cubic yards of ledge and loose rocks from the shoals at Albany. The snag boat *Chattahoochee* was loaned to this improvement during the month of June, and, working below Bainbridge, it removed 85 snags and logs and 3 cubic yards bowlders from the channel, and 70 stumps and logs and 1,493 leaning trees from the banks.

The steamer *Montezuma*, which formerly ran on the Upper Flint between Montezuma and Warwick, has been sold to the Albany Navigation Company, and is now engaged in regular navigation of the stream between Albany and Bainbridge. This transfer of boat, brought about by the opening of a new railroad, renders any improvement of the Flint River above Albany (beyond that already provided for in the present appropriation) a matter of doubtful expediency. The present prospect

Digitized by Google

is, and a future outlook indicates, that there will be no demand of commerce for this water way that will be at all commensurate with the outlay necessary to put the river above Albany in a good navigable condition. I would, therefore, recommend that the full amount of any further appropriation for the Flint River be made available for the river below Albany.

CONDITION OF THE IMPROVEMENT.

As it now stands, there is a channel of a least width of 50 feet and a low-water depth of 3 feet, extending from Albany to Bainbridge, Ga. This channel needs widening and straightening, and it is estimated that two full working seasons, with two drilling barges in good order, will be required for this widening and straightening. It is expected that the shoals below the bridge at Albany will be cleared by one drilling barge before the close of the season of 1892.

RECOMMENDATIONS AND ESTIMATES.

During the present season it is proposed to expend the amount now available in continuing the making of a navigable channel through the rock reefs below the bridge at Albany and in snagging operations, as provided by law, on the portion of the river between Albany and Montezuma.

A small-steamer of about 90 tons formerly ran between Montezuma and Warwick, on the Upper Flint River, but this boat has been sold to the Albany Navigation Company, and now runs between Albany and Bainbridge. So far as known, therefore, no commercial use is now made of the river above Albany, and the opening of a new railroad through that section of the country renders the further expenditure of money in the improvement of this portion of the river of doubtful utility.

I therefore recommend that any appropriation made in the immediate future may be expended entirely below Albany. Between the mouth of the river and Bainbridge, Ga., it is only necessary to remove the snags and logs brought in by the annual winter freshets. Between Bainbridge and Albany there is now a channel of a least width of 50 feet and a low-water depth of 3 feet; but this channel is too narrow and tortuous for safe navigation at low stages of water, and should be widened and straightened. Most of the work will consist in rock removal by drilling and blasting, and when completed the improvement will be practically permanent. For the removal of snags it will, however, always be necessary to maintain a snag boat on the river, at a probable annual cost of $5,000.

The original estimate of the cost of the improvement was $184,862 for the lower river, and $15,100 for the upper river, or $199,962 for the entire river. This contemplated that the improvement should be carried on continuously with sufficient appropriations to provide adequate working plant, but the annual appropriations have not been such as to permit the work to be carried on in this way. For this reason the original estimate must be increased for the completion of the original project; but to what extent can not be determined without further surveys of the localities needing improvement.

No estimate of the cost of completing the existing project is, therefore, submitted.

It is estimated that $40,000 can be profitably expended on the lower river during the fiscal year ending June 30, 1893.

This amount will provide for increased and more efficient plant, consequently more expeditious work.

Digitized by Google

Money statement.

July 1, 1890, balance unexpended	$826.24
Amount appropriated by act approved September 19, 1890	20,000.00
	20,826.24
June 30, 1891, amount expended during fiscal year	4,017.07
July 1, 1891, balance unexpended	16,809.17
July 1, 1891, outstanding liabilities	2,042.48
July 1, 1891, balance available	14,766.69
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

COMMERCIAL STATISTICS FOR FLINT RIVER, GEORGIA.

Above Albany.—The Montezuma Steamboat Company, owning the steamer *Montezuma*, sold the steamer to the Albany Navigation Company, which has changed the name of the steamer. The sale was made last July. No business has been done on the river since that time. The business of running a steamer on the river was so unprofitable that we don't think our people will invest any more money in such an enterprise until the shoals between Warwick and Albany are removed and continuous passage can be had from here to the Gulf.

The S. A. and M. R. R., running from Americus to Savannah, with a branch from Cordele through Warwick to Albany, cuts off so much of the trade that would go to the steamer on the river that a steamer could not be run with any profit.

JNO. F. LEWIS & SON,
Montezuma, Ga.

Between Albany and Bainbridge.

Name and description of boat.	Registered tonnage.	Draft of water.		Number of round trips made between Albany, Ga., and Bainbridge, Ga.	Number of passengers.
		Light.	Loaded.		
City of Albany, stern wheel	49	*Inches.* 16	*Inches.* 30	46	111

Freights carried.

	Tons.		Tons.
Cotton, 1,800 bales	450	Miscellaneous freight, 2,050 packages	61
Cotton seed, 2,100 sacks	105	Naval stores, 1,500 barrels	300
Fertilizers, 8,000 sacks	400		
Provisions, 550 packages	80	Total	1,426
Grain, 400 sacks	30		

Estimated value of above freights in round numbers, $4,760.

The river has been navigable all the time for past 12 months between Albany, the head of navigation, and Bainbridge. At times it has been very difficult, however.

Before any improvement was made boats could only reach Albany when the river was considerably above low-water mark. Now they can reach Albany at any time, although it is difficult, and can only be done by very light-draft boats.

ED. L. WIGHT,
President A. N. Co., Albany, Ga.

Between Bainbridge and the junction with the Chattahoochee River.—The eight steamboats which run on the Chattahoochee and Apalachicola rivers also run on this portion of the Flint River, going to Bainbridge on almost every regular trip. It is, therefore, impossible to state the amount of business done on this portion of the Flint River separately from that done on the Chattahoochee River and Apalachicola River; but in general terms it may be stated that the business on this portion of the river is practically the same as that on the Chattahoochee River, for commercial statistics of which reference is made to the report on that river.

Digitized by Google

P 4.

IMPROVEMENT OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved March 3, 1871, an examination and partial survey of this river were made from Columbus, Ga., to Eufaula, Ala. In 1872 and 1873 the examination and partial survey were carried to the mouth of the river at Chattahoochee, Fla. Pursuant to these examinations a plan of improvement was adopted which provides for a low-water channel 4 feet in depth and 100 feet in width from Columbus, Ga., to Chattahoochee, Fla., a distance of 224 miles, by the removal of snags and other obstructions from the channel and overhanging trees from the banks, by cutting a channel through the rock shoals and deepening sand bars by works of contraction. This improvement at many points is of a permanent character, the bottom of the river being of rock and the banks not easily eroded. At other points the river has a movable bottom and caving banks, and the improvement is attended with the uncertainties, which are characteristic of local works of contraction under such circumstances.

An annual expenditure, estimated at $10,000, will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works of contraction and their further extension or modification as required.

APPROPRIATIONS.

June 18, 1878	$18,000	August 5, 1886	$20,000
March 3, 1879	15,000	August 11, 1888	20,000
June 14, 1880	20,000	September 19, 1890	20,000
March 3, 1881	20,000		
August 2, 1882	25,000	Total	193,000
July 5, 1884	35,000		

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $13,785. With this amount it has been practicable to maintain a good working plant for snagging operations, to clear the channel of all obstructions of that character, and to remove the annual accumulation, except during limited periods, when funds were not available. It has also sufficed to maintain a moderately efficient working plant for operations upon the rock shoals. Works of contraction have been constructed to a limited extent, but it has not been practicable to keep them in repair nor to extend or modify them as required. Navigation has been greatly benefited by the improvements, so that steamboats now make regular trips between Columbus, Ga., and Apalachicola, Fla., running by night as well as by day and with but few accidents or detentions, except at extreme low water. Formerly they could only run by day and were frequently detained several days at an obstruction, and many boats were sunk by striking logs or snags.

WORK DONE DURING THE PAST FISCAL YEAR.

Assistant Engineer Thomas Robinson, in local charge of the improvement, reports as follows:

In July, 1890, extensive repairs were begun on the snag boat *Chattahoochee*. Exhausted funds put a stop to the work until the new appropriation was available. The great fire at Apalachicola, Fla., which destroyed the only "marine ways" accessible for this work, caused a still further delay, and the repairs were not completed until April, 1891.

Digitized by Google

In October the drilling barge was drifted down the river to a marl reef near the mouth of Kowikee Creek, 75 miles below Columbus, Ga., and there set to work. With a crew of 20 men, working 6 weeks, 248 cubic yards of marl and 144 cubic yards of gravel were removed and a channel 100 feet in width and 4 feet in depth secured. The barge was then taken to Fitzsimmon Bend, 27 miles below Columbus, and in 2 weeks 25 trees were removed from the banks, 10 snags and 166 cubic yards of marl were removed from the stream, and the 4-foot channel widened from 75 to 90 feet.

In December the barge was towed back to Burdock Landing and laid up in charge of a watchman until June, 1891, when it was fitted out as a pile boat to work at the improvement of Mound Bar.

* * * * * * *

The channel cleared through Kowikee Shoal is a complete and a permanent piece of work. The channel, partially cleared in Fitzsimmon Bend, is sufficient to meet all practical demands for the present, and will maintain itself.

* * * * * * * *

RECOMMENDATIONS AND ESTIMATES.

The high water of the past winter caused many landslides and brought large quantities of snags and drift into the stream. It is expected that this drift will seriously impede navigation, but the extent of it can not be fully determined until the low-water current has had a full opportunity to assert itself. The sand and gravel bars at the "Mound" and "Woolfolk" and the marl and sand obstructions in Francis Bend are a constant source of stoppage to the boats. King Rock and other hard rocks in that neighborhood, about 200 miles from Columbus, are positively dangerous to steamers, although there is a sufficient depth in the tortuous channel around them.

At the Mound and Woolfolk Bar there have been extensive caving of banks and considerable changes in the channels. If sufficiently large appropriations were made to permanently improve these localities with substantial and lasting works of shore protection and contraction, as well as to improve the channels at Francis Bend and King Rock, it is believed that the navigation of this stream, from Columbus down, would be comparatively easy and safe at all stages of water, and that thereafter the only expenditure necessary would be that required for keeping the works in repair and for removing the annual accumulation of logs and snags brought in by the winter freshets. This annual cost of maintenance is estimated at $10,000 per year.

On account of the high stage of water during the past spring it has not been practicable to make a detailed examination of the four localities mentioned above and to prepare accurate estimates of the cost of improving them, but it is anticipated that this cost will not be less than $150,000, and there is no doubt that $75,000 can be profitably expended on this river during the fiscal year ending June 30, 1893.

The balance available of the present appropriation will be expended during the low-water season of 1891 in snagging operations and in such slight improvement at Mound Bar as may be possible with the small amount

Money statement.

July 1, 1890, balance unexpended	$2,185.30
Amount appropriated by act approved September 19, 1890	20,000.00
	22,185.30
June 30, 1891, amount expended during fiscal year	11,108.32
July 1, 1891, balance unexpended	11,076.98
July 1, 1891, outstanding liabilities	526.71
July 1, 1891, balance available	10,550.27
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	75,000.00

Digitized by Google

COMMERCIAL STATISTICS FOR CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA.

The following statement of business done by the steamboats named below during the fiscal year ending June 30, 1891, has been compiled from statements furnished by Capt. W. R. Moore, agent of the People's Line of boats, and by Capt. G. L. Lapham, owner and master of the *W. D. Ellis*. These boats run from Columbus, Ga., to the Junction of the Chattahoochee and Flint Rivers; thence up the Flint River to Bainbridge, Ga.; then, returning to the Junction, down the Apalachicola River to Apalachicola, Fla. On the return trip they go, first, to Bainbridge, then to Columbus. They stop at any intermediate landings where business is offered:

Stern-wheel steamboats.	Registered tonnage.	Draft of water.		Number of round trips.*	Number of passengers.
		Light.	Loaded.		
		Inches.	*Feet.*		
Naiad	120	20	4	52	
Pactolus	150	24	5	24	
W. D. Ellis	150	25	4	70	
Milton H. Smith	110	24	5	52	36,960
Fannie Fearn	179.32	25	5	24	
Queen City	150	21	5	18	
Apalachee	150	28	5	8	
Lotus No. 2					

* Between Columbus and Bainbridge, Ga., Apalachicola, Fla., and ninety-two intermediate points.

Freight carried.

	Tons.		Tons.
Cotton, 46,875 bales	11,718	Provisions, 98,000 packages	4,700
Cotton seed, 99,528 sacks	5,140	Grain, 120,000 sacks	9,000
Fertilizers, 152,800 sacks	15,180	Miscellaneous freight, 46,600 packages	2,500
Hides and skins, 530 packages	50	Naval stores, 45,000 barrels	9,000
Live stock, 849 head	180	Iron, 5,580 bundles	8,930
Lumber, 2,246,900 feet	4,600		
Staves, 400,000 pieces	1,880	Total weight	72,878

Estimated value of above freights (in round numbers), $10,385,000.

It has not been practicable to obtain any statement of the business done by the *Lotus No. 2*. This boat ran for a time during the first part of the fiscal year, but has since been laid up and its ownership is in litigation.

P 5.

IMPROVEMENT OF LA GRANGE BAYOU AND HOLMES RIVER, FLORIDA.

PLAN OF IMPROVEMENT.

The La Grange Bayou extends about 2 miles in a northeasterly direction from the north side and near the head of the Choctawhatchee Bay, Florida, and into it flows Cedar Creek, a deep stream from 90 to 160 feet wide, on which is situated the town of Freeport, 1½ miles above the head of the bayou.

As directed by the act of March 3, 1881, an examination of this bayou was made and an estimate submitted for deepening the channel by dredging to admit the passage of vessels drawing 4½ feet at mean low water, at a cost of $19,994.30.

The act of August 2, 1882, provided for the expenditure of $2,000 of the $20,000 appropriated for the improvement of the Choctawhatchee River. This amount was expended principally in the removal of snags and logs from the channel and in dredging about 3,500 cubic yards of

Digitized by Google

mud from the shoalest part of the channel. Since then no work has been done.

The act of August 5, 1886, appropriated $2,000 for the improvement of La Grange Bayou, but as so small a sum could not be profitably expended it was decided to hold it until a further appropriation was made.

The act of August 11, 1888, appropriated $3,000 to *complete* the improvement of La Grange Bayou, improving Holmes River as far as the town of Vernon.

In February, 1889, an examination of both La Grange Bayou and Holmes River was made. This examination showed that the improvement could not be completed with the amount available, and the Secretary of War therefore directed that no further expenditure should be made from the appropriations.

There is a balance still available from the appropriations of August 5, 1886, and August 11, 1888, of $4,839.20.

The act of September 19, 1890, made an appropriation for improving La Grange Bayou, Florida, continuing improvement of Holmes River, $3,000.

RECOMMENDATIONS.

Previously to the building of the Pensacola and Atlantic Railroad, the town of Freeport was the port of entry for a large section of country surrounding it, and contained seven flourishing stores, and considerable commerce passed through La Grange Bayou; but since the completion of the railroad most of the territory formerly supplied through Freeport now draws its supplies by way of the railroad and Choctawhatchee River.

The town of Freeport at the time of the last examination contained but one store, and its commerce was carried on by one small schooner, which made irregular trips between it and Pensacola.

It is not considered that the present or prospective commerce of La Grange Bayou justifies any further expenditure at present for its improvement, and it is, therefore, recommended that the amount which has been appropriated, but which can not be legally expended on account of the wording of the act, be turned into the Treasury.

During the past winter the snag boat belonging to the Choctawhatchee River improvement was employed on the Holmes River, and cleared out the snags and overhanging trees which obstructed it from its mouth to Vernon, Fla., a distance of about 28 miles.

There are no bars in this river, and it is probable that its navigation will not be again impeded by snags or overhanging trees for several years. There is little or no commerce on it. It is, therefore, recommended that no further appropriation be made for its improvement until such time as the necessities of its commerce may require it.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer J. E. Turtle, in local charge of the improvement, reports as follows:

The plan of improvement calls for the removal of all logs and snags from the channel and overhanging trees from the banks, between the mouth and the town of Vernon, Fla., an estimated distance of 28 miles.

In accordance with approved project for this improvement the plant for the Choctawhatchee River was transferred to this river on October 28, and the removal of obstructions began on November 3, 1890. Work was continued until February, when the town of Vernon was reached. The boat was then dropped down the river,

Digitized by Google

doing, on the way down, some slight work omitted on the upstream trip. The work performed was:

Overhanging trees felled and cut up	2,671
Overhanging trees trimmed	924
Stumps removed level	117
Snags removed	154
Logs on banks cut	31

The work accomplished has resulted in removing all obstructions from the channel and overhanging trees from the banks; and as this river is small and sluggish, containing no bars, it is in as good a condition as can be hoped for; and as there are no caving banks the improvement made will be practically permanent. The present commerce is confined to occasional trips of a "push boat," and that carried on a small barge towed by a small steam tug. These boats go no higher than Millers Ferry, 12 miles from the mouth, and go as far as Port Washington on Choctawhatchee Bay. At present there is no trade on the stream to justify any party sending a boat into it. Possibly a trade could be established, during several months in the year, that would be a paying investment for a small and suitable boat. To establish this would require an outlay at first, and by a party who could afford to wait for a profit. This, no doubt, to small capitalists, has the appearance of a venture, which I doubt very much will be made for years to come. Until this has been done, and it is proven that a commerce can be sustained, I would strongly recommend that no more money be appropriated for this river.

Holmes Valley has an area of about 20 square miles of very fertile land, capable of producing cotton, corn, oats, sweet potatoes, and sugar cane.

The yield of these products, when properly cultivated, is far above the average. Also much honey, eggs, and fowls are received; some wool; the grazing is good; and a turpentine trade could be established.

Nearly all the products, as well as the supplies, are hauled, chiefly by ox-teams, to and from the Pensacola and Atlantic Railroad, a distance of 16 to 24 miles. The farms are at present small, and only moderately well cultivated. The development of such a section will be slow, but I have no doubt will to some extent come about; the first step towards this, viz, the improvement of the Holmes River, traversing it, is completed, and nothing more should be looked for in this direction until the existing demands of commerce, not prospective, show that a further expenditure is necessary.

Money statement.

July 1, 1890, balance unexpended	$4,839.20
Amount appropriated by act approved September 19, 1890	3,000.00
	7,839.20
June 30, 1891, amount expended during fiscal year	3,000.00
July 1, 1891, balance unexpended	4,839.20

COMMERCIAL STATISTICS FOR HOLMES RIVER, FLORIDA.

Name and description of boats.	Registered tonnage.	Draft of water.		Number of round trips between Millers Ferry and Port Washington.
		Light.	Loaded.	
Barge	Not registered	*Inches.* 8	*Feet.* 2	1

Freight carried.

	Tons.
Cotton, 50 bales	12
Lumber, 20,000 feet	10
Grain, 200 sacks	7
Provisions	10
Miscellaneous freight	15
Total	54

Estimated value of above freights, in round numbers, $6,000.

Digitized by Google

The river has been navigable all the time to Vernon, and I am not acquainted with the stream above there.

No benefits to any great extent have been derived from the work done, from the fact that no boat, except my barge, has been run on it.

The prospective advantages, if the improvement is continued, are good. There are several, or different, persons speaking of putting a boat on Holmes River in its present condition, with the hope that the improvement will be continued.

I have no doubt in my mind but what there will be a boat run on this stream in the near future.

I think that there would be at least the following produce to ship down the river, each year, if a boat was on it, to wit, 500 bales of cotton, 500 barrels of syrup, several thousand bushels of potatoes, and other farm products adapted to this climate, in proportion; besides, the wood trade would be inexhaustible.

A. Q. JONES,
Millers Ferry, Florida.

P 6.

IMPROVEMENT OF CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved March 3, 1871, an examination and partial survey of this river was made from the mouth of the river to Geneva, Ala., an estimated distance of 125 miles; under an act approved March 3, 1879, a further examination was made from Geneva to Newton, Ala., an estimated distance of 37 miles. Under the act of August 11, 1888, a second examination was made from Geneva to Newton, Ala., for low-water navigation.

The original plan of improvement provided for the improvement of the river to obtain a low-water navigable channel from its mouth to Geneva, and a navigable high-water channel from Geneva to Newton. The act of September 19, 1890, provided for "improving Choctawhatchee River, Florida and Alabama, continuing improvement under existing projects, and to secure low-water navigation between Geneva and Newton, $12,500: *Provided*, That no part of said sum shall be expended above Hollis Bridge until a draw, approved by the Secretary of War, is put in said bridge."

The present approved project therefore provides for obtaining a low-water navigable channel from the mouth of the river to Newton, Ala., an estimated distance of 162 miles by the removal of snags and logs from the channel and overhanging trees from the banks, and by excavating rock shoals, and deepening sand bars by works of contraction and shore protection.

This improvement must be maintained by the removal of fresh obstructions each year. The banks of the river are heavily timbered, and the annual accumulation is large.

APPROPRIATIONS.

June 23, 1874	$5,000	July 5, 1884	$15,000
March 3, 1875	5,000	August 5, 1886	15,000
August 4, 1876	5,000	August 11, 1888	10,000
March 3, 1879	5,000	September 19, 1890	12,500
June 14, 1880	7,000		
March 3, 1881	10,000	Total	107,500
August 2, 1882	18,000		

Digitized by Google

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $5,972.22. With this amount it has not been practicable to maintain a suitable plant for expeditious and economical work. One snag boat has been worn out, and a new one was built in 1889. Operations have been confined almost exclusively to the removal of logs and snags from the channel, and the cutting of overhanging trees from the banks. This work has been done mainly between Caryville and Geneva, on which portion of the river most of the commerce is carried on, and occasionally work has been done between Geneva and Pate Landing, about 25 miles above. The imperfect improvement thus accomplished has resulted in great benefit to navigation, the effects of which are shown by the large increase in the trade of Geneva, and by the rapid settlement of the surrounding country. Steamboats now run regularly between Geneva and Caryville, but at low water full loads can not be carried, and they are much delayed by several sand bars, which could be readily deepened if the appropriations were sufficiently large.

Since the building of the Pensacola and Atlantic Railroad, there has been but little steamboat navigation below Caryville, but this portion of the river is much used for the movement of logs and sawn timber rafts to the market at Pensacola. It is obstructed at low water by logs and snags, but the available funds have not permitted any work to be done on it.

WORK DONE DURING THE PAST FISCAL YEAR.

Asst. Engineer J. E. Turtle, in local charge of this improvement, reports as follows:

At the beginning of the fiscal year the snag boat and property was at Caryville, Fla., in charge of a watchman. This was due to a lack of funds for active operations. On October 27, 1890, the plant was transferred to the Holmes River Improvement, where it was employed until February 14, 1891, when it was again returned to the Choctawhatchee River and placed in charge of a watchman. On May 20, the river being low enough to admit of operations, the boat was put in commission and began working up stream from Caryville, Fla., removing obstructions in accordance with the approved project.

* * * * * * *

The entire expenditure thus far under the approved project has resulted in improving the navigation of the river between Caryville, Fla., and Geneva, Ala., causing a material increase in its commerce.

* * * * * * *

It is contemplated to make some changes in the snag boat by putting in machinery and a wheel, which will greatly facilitate operations upon this river.

During May I made an examination of the river between Caryville and Geneva. I found in all of the bends many snags to be removed, and very shoal water on Buzzard and Pitman Bars. I am in hopes, with a favorable season, to greatly improve the navigation of this river between Caryville and Geneva, and to be able to increase the depth on Pitman Bar.

* * * * * * *

RECOMMENDATIONS AND ESTIMATES.

The estimate of the cost of this improvement under the project of 1880 was $122,832. The report on the examination for low-water navigation between Geneva and Newton, estimated the cost of securing a channel 3 feet deep and 60 feet wide at $57,125. From Geneva to Hollis Bridge, 7 miles below Newton, the work will consist almost exclusively of the removal of snags, sunken logs, and overhanging trees. Above Hollis Bridge the work will consist in excavating a channel through a number of shoals, which consist of hard blue clay and rock,

Digitized by Google

and which aggregate about 4,095 feet in length. Under the law it is not proposed to do any of the latter work as long as any of the existing bridges obstruct navigation.

The Alabama Midland Railroad, recently finished from Montgomery, Ala., to Bainbridge, Ga., passes through Newton, and it is doubtful if that portion of the river between Geneva and Newton would now be much used even if the improvement were completed. Between Geneva and Caryville, however, a number of steamers make regular trips, and the easy navigation of this portion of the river is of the greatest importance to a large section of country, of which Geneva is the central point.

In my project for the expenditure of the appropriation of September 19, 1890, I therefore recommended that on account of the necessities of this section of the river, and of the limited appropriation, the greater part of the work should be done upon it, and that the snag boat should proceed above Geneva only in the event of the urgent work below being finished before the funds were exhausted. I also recommended that in order to operate the snag boat more economically, it should be provided with the necessary machinery, and a stern wheel. These recommendations were approved by the Chief of Engineers, and the balance available will be expended during this year in carrying them out. On account of the many changes which have taken place since the survey and estimate of 1880, it is not now possible to submit an accurate estimate of the cost of completing the existing project.

The ultimate cost of the improvement would be very much reduced if funds were appropriated in sufficient amounts to enable suitable works of contraction and shore protection to be built where needed. Hitherto it has not been possible to do such work.

The annual cost of removing the logs and snags brought in by the winter freshets, and of maintaining any improvement which may be effected, is estimated at $5,000.

In order to proceed with the improvement economically, at least $30,000 should be provided for the fiscal year ending June 30, 1893.

Money statement.

July 1, 1890, balance unexpended	$873.77
Amount appropriated by act approved September 19, 1890	12,500.00
	13,373.77
June 30, 1891, amount expended during fiscal year	1,303.37
July 1, 1891, balance unexpended	12,070.40
July 1, 1891, outstanding liabilities	1,440.01
July 1, 1891, balance available	10,630.39
Amount that can be profitably expended in fiscal year ending June 30, 1893. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	30,000.00

COMMERCIAL STATISTICS FOR CHOCTAWHATCHEE RIVER, FLORIDA AND ALABAMA.

Name and description of boats.	Registered tonnage.	Draft of water.		Number of round trips made between Geneva and Caryville.	Number of passengers.
		Light.	Loaded.		
		Inches.	*Inches.*		
Mary Alice, stern-wheel river boat	39.37	14	32	461	407
Lena C., stern-wheel river boat	34	15	36		
Dexter, stern-wheel river boat	120	20	42		

Digitized by Google

Freight carried.

	Tons.		Tons.
Cotton, 7,510 bales	1,875½	Miscellaneous freight	157
Fertilizers, 26,091 sacks	2,609	Turpentine, 103 barrels	23
Hides and skins, 20 packages	6¾	Resin, 153 barrels	30½
Live stock, 25 head	6½	Railroad equipments	45
Lumber, 54,450 feet	32		
Shingles, 300,000	150	Total	8,124
Provisions	1,866		
Grain, 17,477 sacks	1,323		

Estimated value of above freights (in round numbers), $790,903.

From December 1 to about April 1 the Choctawhatchee River is navigable from Caryville, Fla., to Pate Landing.

From April 1 to December 1, or during low water, between Geneva, Ala., and Caryville, Fla.

J. E. TURTLE,
Assistant Engineer.

P 7.

IMPROVEMENT OF HARBOR AT PENSACOLA, FLORIDA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 18, 1878, the improvement was commenced by the removal, in 1879–'80, of certain wrecks forming obstructions to navigation. In 1879 an examination and partial survey was made for the purpose of ascertaining the extent and probable cause of the shoaling of the main ship channel at a point known as the "Inner Bar." In 1881 the present plan of improvement was adopted in conformity to the recommendations of the Board of Engineers for fortifications and for river and harbor improvements. The project provides for the construction of jetties near the site of Fort McRee to prevent further abrasion of the shore line and consequent changes in the tidal currents, and to preserve the site for defensive works, and for the dredging of a channel 24 feet deep and 300 feet wide across the inner bar.

The ultimate cost of this improvement is not estimated in the original project, which assumes that it will exceed $150,000. The annual appropriations have not been sufficient to enable this project to be carried to a rapid completion, as was originally contemplated. In consequence the channel has never been dredged to a greater width than 120 feet, and a very large proportion of the appropriations made has been expended in redredging, and repairing and rebuilding the jetties. Strong tidal currents cross the inner bar almost at right angles, and it is not believed that a permanent improvement can be effected by dredging. The work of shore protection as completed in May, 1890, is believed to be practically permanent, but it may require extension. No dredging has been done since 1886, at which time the dredged channel over the inner bar was reported as having a depth of 24 feet and width of 120 feet at mean low water. This channel has since been gradually shoaling. The original project provided for no improvement of the outer bar to correspond with that of the inner bar.

APPROPRIATIONS.

June 18, 1878	$20,000	August 5, 1886	$20,000
March 3, 1879	10,000	August 11, 1888	35,000
June 14, 1880	40,000	September 19, 1890	25,000
March 3, 1881	20,000		
August 2, 1882	50,000	Total	275,000
July 5, 1884	55,000		

Digitized by Google

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $19,642.85. With this amount it has never been practicable to complete the dredging of the prescribed channel through the inner bar. Partial dredging was done at various times between the years 1882 and 1886. At the conclusion of the dredging in 1886 it was reported that the channel over the inner bar was 24 feet deep and 120 feet wide. No dredging has since been done, and in April, 1890, the least depth at mean low water on the inner bar was 19.6 feet, and on the outer bar 22.1 feet.

The work of preventing further abrasion of the shore line near Fort McRee was begun in 1881, and continued until April, 1890, whenever funds were available for the purpose. The work was at first of a tentative character. Two jetties, having lengths of 360 and 220 feet, respectively, were built nearly perpendicular to the shore line north of Fort McRee. The jetties were constructed of close piling filled with alternate layers of brush and stone, with side slopes of the same construction. These jetties were exposed to the action of violent storms from the Gulf, the waves which break upon the shore having great destructive power. They were also exposed to the attacks of the teredo, which are very destructive in these waters. From these causes more than 75 per cent. of the work had been destroyed previous to 1888, notwithstanding that much repair and auxiliary work had been done to preserve them. As their usefulness in preserving the shore line had been demonstrated it was then decided to rebuild them in a substantial manner, by covering what remained of them with a coping and side slopes of heavy stone and concrete blocks. This work was completed as far as at present appears to be necessary, in April, 1890. Two thousand six hundred and eighty-one tons of stone (granite) have been used; the larger stone weighing from 1 to 4 tons. Three sizes of concrete blocks—3 by 3 by 5, 3 by 3 by 10, and 4 by 4 by 6 feet—have been used, weighing, respectively, about 3, 6, and 6¾ tons. In all, 402 cubic yards of blocks have been used. Each jetty has been coped with a mass of concrete, built in place. The past spring has been unusually stormy, and the reconstructed jetties have been exposed to several unusually severe storms, which they have withstood perfectly. No settlement or derangement of the work whatever has been apparent.

When the improvement was begun the beach-line had receded to the walls of Fort McRee, and the greater part of the fort had been undermined and destroyed. Below the fort the beach line is now protected by the ruins of the old water battery, which was built of brick laid in cement. No necessity for the further extension of the shore protection by jetties is now apparent.

WORK DONE DURING PAST FISCAL YEAR.

At the beginning of the fiscal year the only work in progress was a survey of the entrance to the harbor; this was being made by Asst. Engineer J. E. Turtle, in local charge of the improvement.

The field work of this survey was completed in August, 1890, and the necessary office work was finished in October, and Mr. Turtle submitted his report on November 19, 1890.

On January 7, 1891, I submitted a report on this survey, in which I requested that the whole subject of the further improvement of Pensacola Harbor should be referred to a Board of Engineers, and that, pending the report of this Board, no expenditure of the appropriation of $25,000, by the act of September 19, 1890, should be made.

Digitized by Google

By Special Orders, No. 5, Headquarters, Corps of Engineers, January 17, 1891, a Board of Engineers was appointed to report upon the improvement of the harbor.

This Board has since held two meetings, and it is expected that their report submitting a project for the further improvement of the harbor will be submitted during the month of July, 1891.

The only other work done during the year has consisted in the care and preservation of public property pertaining to the improvement, and in the further tests of cements used in the construction of the jetties, and in such further examinations of the harbor as were required to furnish data called for by the Board of Engineers.

Early in June, 1891, it was reported that serious trouble was experienced in taking loaded vessels out of the harbor. Several steamships had grounded on the inner bar, and in their efforts to get off sand lumps had been thrown up in the channel, which seriously impeded navigation. Several vessels in the harbor had been loaded to 23 feet, and were unable to leave.

The state of affairs having been reported to the Chief of Engineers, he authorized, by telegram dated June 19, 1891, the hiring of the suction dredge *Bayley* from the Mississippi Jetty Company to do such dredging on the inner bar as was practicable with the money available.

In accordance with this authority, an agreement was made with the owners of the dredge, and on June 29, 1891, work was commenced.

The dredge was hired for a period of 45 days, and it is expected, with such weather as is to be expected during this season of the year, that a channel 150 feet wide, and sufficiently deep to admit the passage of vessels drawing 23 feet of water, will be dredged in that time.

RECOMMENDATIONS AND ESTIMATES.

Pending the report of the Board of Engineers, no recommendations nor estimates for the further improvement of the harbor are submitted.

Money statement.

July 1, 1890, balance unexpended		$8,155.11
Amount appropriated by act approved September 19, 1890		25,000.00
		33,155.11
June 30, 1891, amount expended during fiscal year		7,585.15
July 1, 1891, balance unexpended		25,569.96
July 1, 1891, outstanding liabilities	$345.21	
July 1, 1891, amount covered by uncompleted contracts	18,000.00	
		18,345.21
July 1, 1891, balance available		7,224.75
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		500,000.00

COMMERCIAL STATISTICS FOR HARBOR AT PENSACOLA, FLORIDA, 1891.

Value of exports to foreign ports	$3,939,676
Value of exports to coastwise ports	421,140
Total value of exports	4,360,816

Digitized by Google

Value of imports from foreign ports	$152,894
Value of imports from coastwise ports	140,171
Total value of imports	293,065
Duties on imports and miscellaneous collections	32,964
Vessels entering from foreign ports	402
Vessels entering from coastwise ports	143
Total vessels entering	545
Vessels cleared for foreign ports	445
Vessels cleared for coastwise ports	107
Total vessels cleared	552
Vessels employed in traffic of port:	
Sailing	137
Steam	28
Total	165
Lumber exported ..... feet, B. M.	250,708,924

REPORT OF CAPTAIN PHILIP M. PRICE, CORPS OF ENGINEERS, UPON IMPROVEMENT OF PENSACOLA HARBOR, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., January 7, 1891.

GENERAL: I have the honor to forward herewith report of Assistant Engineer J. E. Turtle, on the survey of the entrance to Pensacola Harbor, Florida, which was authorized by the Chief of Engineers, under date of March 28, 1890.

Mr. Turtle's report gives in detail the results of the survey, which was made during the summer of 1890, and I will therefore not repeat them.

The improvement of Pensacola Harbor was begun by the United States Government in 1878, by the removal of certain wrecks which obstructed the channel.

In 1880 the project of Captain Damrell, for the further improvement of the harbor, was referred to the Board of Engineers for fortifications and for river and harbor improvements, and the report of the Board, dated February 12, 1881, is printed in the Annual Report of the Chief of Engineers for 1881, page 1177.

In accordance with the recommendation of the Board a project was approved which provided for dredging a channel 300 feet wide and 24 feet deep at mean low water across the inner bar for the temporary relief of navigation, and for protecting the shore line near Fort McRee from further abrasion by the construction of jetties and works of shore protection, with a view to retaining this position for defensive purposes, and to prevent further injurious changes in the tidal currents. Between 1881 and 1886 some dredging was done on the inner bar, and it was reported that a channel 120 feet wide and 24 feet deep had been obtained in 1886. Since then no dredging has been done, and the channel has gradually shoaled until it had a least depth of 19.6 feet at mean low water in April, 1890.

Between 1881 and 1887 the further abrasion of the western shore line,

Digitized by Google

near Fort McRee, was stopped by the construction of two jetties north of the fort, and nearly at right angles to the shore, having lengths repectively of 360 and 220 feet. The jetties were originally of a tentative character, and were built of two parallel rows of close piling filled with alternate layers of brush and stone, with side slopes of similar construction. They were exposed to the attacks of the teredo and to the destructive action of severe storms.

In 1888 not more than 75 per cent. of these jetties remained, notwithstanding that much repair and auxiliary work had been done to preserve them. Their usefulness in preserving the shore line had, however, been demonstrated, and it was then decided to rebuild them in a more substantial manner by covering them with a coping and side slopes of heavy stone and concrete blocks.

This work was finished in April, 1890, and has so far been entirely satisfactory.

The river and harbor act of August 5, 1886, directed a resurvey of the outer and inner bars at Pensacola Harbor, Florida. The report of this resurvey, with a project and estimate for the permanent improvement of the harbor, was submitted on February 8, 1889, and is printed in the Annual Report of the Chief of Engineers for 1889, page 1403. No action has been taken on this report. On account of lack of funds the resurvey was not made with a detail that was considered desirable, and on March 28, 1890, the Chief of Engineers approved my request for authority to make a detailed survey of the entrance to the harbor, which should include careful velocity observations.

The river and harbor act of September 19, 1890, appropriated $25,000 for continuing the improvement of Pensacola Harbor.

In my project dated September 23, 1890, I stated:

> When this report (of the survey) is received I respectfully recommend that the whole subject of the improvement of Pensacola Harbor be referred to a Board of Engineers, especially constituted for the purpose, who will visit the locality and afford an opportunity to those interested in the improvement to present their views. In the meantime I would prefer to make no recommendation as to the expenditure of the $25,000 just appropriated.

This project was approved by the Chief of Engineers on October 1, 1890, and accordingly I now respectfully request that this report and accompanying maps, together with my report of February 8, 1889, may be referred to a Board of Engineers, who shall take into consideration the whole subject of the further improvement of Pensacola Harbor, and recommend a project for such improvement.

The following tracings* are transmitted in a separate package:

1 tracing, entrance to Pensacola Harbor, Florida, and profile.
1 tracing, entrance to Pensacola Harbor, Florida, showing comparative contour lines.
1 tracing, entrance to Pensacola Harbor, Florida, plan showing tidal velocities and directions.
10 diagrams of tidal velocities.
3 tabulated tidal velocity observations.

Very respectfully, your obedient servant,

PHILIP M. PRICE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

*Not printed.

Digitized by Google

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 14, 1891.

Respectfully submitted to the Secretary of War, with recommendation that a Board of Engineers be appointed, to consist of Capt. P. M. Price, Capt. W. M. Black, and Lieut. O. M. Carter, Corps of Engineers, to consider and report upon the subject of the improvement of Pensacola Harbor, the Board to meet at Pensacola on the call of the senior member, and its expenses to be paid from appropriation for Pensacola Harbor.

With the sanction of the Secretary the order constituting the Board will be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT, *January 16, 1891.*

Approved as recommended by the Chief of Engineers.
By order of the Assistant Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

REPORT OF MR. J. E. TURTLE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Warrington, Fla., November 19, 1890.

CAPTAIN: Report upon the survey of Pensacola Harbor, made during the summer of 1890, is respectfully submitted.

This survey was intended to be so complete that a sufficient amount of reliable information, supplementing that obtained in 1888, and bearing upon the natural and changeable conditions found here, could be submitted to enable a Board of Engineers to better determine the proper method to adopt for the further or permanent improvement of the entrance to this harbor. With this object in view the following steps were taken for the purpose mentioned:

Relocation of beach lines, to determine their recession or advancement.

Soundings over the entrance area, to locate the shoals and channels by 1-foot contours, for the purpose of ascertaining, by comparison with other surveys, the natural drift of permanent change arising from the natural forces existing here, and for the purpose of making a relief map of the harbor.

Velocity observations of both ebb and flood, to better determine the amount and direction of the resultant flow.

Borings, a sufficient number to determine the geological formation of the shoals in the harbor entrance.

These four steps were the main ones in the survey, and were prosecuted whenever the conditions were favorable; these, however, were unfavorable the greater part of the time, and the completion of the survey, particularly of the field work, was accordingly delayed. Whenever it was possible to do so, office work was advanced when the weather would not admit of field work being done. The plans and diagrams were completed on October 9.

OPERATIONS.

Relocation of beach lines.—These were located by offsets from a transit line meandering the shores; in all, 6¼ miles of beach line were located.

Soundings.—Inside the entrance proper 39 ranges were located by triangulation from the old stations. These ranges radiated from station "Fort Pickens" and over the area covered by these. Soundings were located by a boat traversing the ranges from the beach on the north and west side of the entrance to the Santa Rosa Beach. A flagman in the boat indicated by hoisting a flag that the lead had been thrown; the lowering of the flag indicated that at that instant the lead-line had been read. A transit-man at Station "McRea," with his instrument O on Station "Pick-

Digitized by Google

ens," read and recorded the angle between that station and the flag in the boat, which, from the fact that the location of each range was known, located the sounding. Outside the harbor entrance the soundings were located by means of two transits, one each at Stations "Pickens" and "McRee," the zero reading "Pickens" and "McRee," respectively, and the angles read from these stations to a signal flag, operated by the recorder of depths on the boat from which the soundings were taken. For method in detail, reference is respectfully made to Report of Chief of Engineers for 1889, part 2, page 1409. The boat engaged for this purpose, as well as operating the survey generally, was the tug *Willie C.* Being familiar with the locality, I in person directed from the tug the directions and courses of the boat until the ground had been thoroughly crossed and recrossed. These soundings were carried seaward to the 30-foot curve, it being thought that any method of improvement would not, in any event, contemplate a greater channel depth than this. In all, 6,109 soundings were located.

Cross sections of the shore.—Every 100 feet, and for a distance back from water-line until the highest elevation was reached, and extending over the 6¼ miles of beach above mentioned, were taken, to be used in making relief map of harbor.

Velocity observations.—Ten stations were selected from which simultaneous velocity observations were to be taken, five of these stations being employed at a time. The stations are as follows:

Station No. 1.—Entrance buoy.
Station No. 2.—Caucus buoy No. 1.
Station No. 3.—Caucus buoy No. 3.
Station No. 4.—Caucus buoy No. 5.
Station No. 5.—A spar buoy placed on Caucus directly in line with discharge of ebb across Caucus.
Station No. 6.—A spar buoy inside of this in 12′ of water.
Station No. 7.—Bell buoy.
Station No. 8.—East Bank buoy.
Station No. 9.—Swash-channel buoy.
Station No. 10.—Mid-channel buoy.

For a more familiar location of these stations see Plan No. 3. It was thought that these stations were so located that current observations of tidal flow passing them would give a knowledge of the direction of the distribution of the tidal discharge from any portion of the cross section at the gorge and the approach of the flood to the harbor, as well as ascertain the velocity of the currents passing over the different shoals and parts of the channels. The observations consisted of surface, mean, and bottom velocities. For surface velocities a mariner's log was used, one corner of which was weighted sufficiently to make the log assume an upright position without any strain on the measuring line, and also to slightly immerse the log, so that it would present an area to the surface flow. For mean velocity the usual loaded rod was employed, of course the rods being cut to suit the depths at the stations where they were intended to be used. For bottom velocity the usual double float was employed. The measuring cord was as slight as would insure the hauling home of the different floats and was tagged from zero to 100 feet, a tag marking off each 25 feet. Between the zero tag and the float about 40 feet of strong line was left for the purpose of letting the float obtain the velocity of the current before the observation began. The observers' watches were all made to read the same, and the observations began when the flow in the direction for which they were intended was strong enough to carry the float out with any marked decisiveness. An observation was taken every ten minutes, which gave two of each kind each hour. When the zero tag passed the taffrail of the boat, which of course was anchored, the time or watch reading was recorded. When the second tag passed, the watch reading was again recorded, and similarly during the entire observation. The number of seconds and velocity, as shown on tables herewith, was deduced from these watch readings in the office. It will be seen, therefore, that each observer was recording the same velocity at the same moment. Each observer was provided with a mariner's compass and the magnetic bearing of the direction taken by the float recorded.

Owing to the fact that we have here but one ebb and one flood each 24 hours, these observations had to be carried always into the night, and frequently the entire observation, lasting 12 hours, occurred at night. In this case lanterns were used, and the measuring string attached to the float, held across the face of the compass after the recording of each observation was completed, would give the magnetic bearing traversed by the float.

Observations extended over eight entire ebbs and three entire floods; in all, 3,810 observations were taken.

This method, while it offers some advantages, is not entirely satisfactory, and the velocities obtained were somewhat in excess, I think, of the actual current velocities. This is more true in cases of the mean and bottom velocities; the line floating on the surface is carried out by the velocity of the float to which it is attached, in-

Digitized by Google

fluenced, however, somewhat by the velocity of the surface-water, creating a bag in the line; if the line is delayed by holding slightly it can not be ascertained well, when the holding does not retard the flow of the float. The error is not great, yet it does exist and can not be eliminated except by guessing at the difference between the length of the curve and the chord, which was never attempted, and the velocities recorded are those indicated by the measuring string.

The weather selected for this part of the work was generally good, and the wind too slight to have any influence whatever upon the currents.

During these observations a record of the tidal gauge was kept, both in the lagoon and in the gauge well in the south jetty.

Borings.—One boring was taken on the crest of Caucus Shoal, and one on the shoalest depths of the inner and outer bar channels. There is evidently a uniformity in the geological formation of all these shoals, and it was thought that the information derived from these borings would apply equally well to any other portion of the harbor entrance. The device employed in making these borings was the sand pump made for the survey of 1888. For description, reference is respectfully made to Report of Chief of Engineers for 1889, Part II, page 1410.

OFFICE WORK.

Beach lines.—The original trigonometrical stations were carefully located on a map, and from these the data, giving location of beach lines, worked up, the new transit lines, and offsets plotted, giving location of beach lines for 1890.

Soundings.—These were carefully plotted with a Keuffel & Esser protractor reading to 1 minute. To avoid confusion such soundings only were plotted as would enable the 3-foot contours to be located, all intermediate ones being omitted. Accordingly on plan No. 1 the channels and shoals are indicated by 3-foot contours.

Velocities.—The magnetic bearing of the velocity observations taken were all plotted to scale, as shown on diagrams herewith.

Borings.—The location of the borings taken will be seen on plan No. 1.

Besides plotting the recent survey, coast survey charts for 1856 and 1881 have been enlarged to scales used for plans of 1890, and a sufficient number of curves from those years have been transferred to our maps to show more clearly the tendency of permanent changes. (See plan No. 2.) Also the curves of 1822 and 1847 in the immediate vicinity of Fort McRee, there being no information in this office to extend these further, have been put on this plan.

A relief map of the harbor will be completed as soon as practicable.

DESCRIPTION.

For a general description and outline of the harbor, reference is respectfully made to Report of Chief of Engineers, Part II, pages 1404, 1405, 1410, and 1411, but as the knowledge of tides is now more complete than at the time the report referred to was made, it may be well to again mention them.

We have here but one high and one low tide every 24 hours, the fluctuations being greatest, of course, at times of new and full moon. During periods most remote from these the ebb sometimes stops for a short time and again starts, which would, I presume, indicate the influence of a second tide. This is not frequently observed. An average rise and fall of the tide from certain periods just before new and full moon to certain periods thereafter is about 1.6 feet, and for corresponding periods before and after first and last quarter, about 0.9 feet. During greatest fluctuations the turn of the tide varies about 1 hour from day to day, and so continues until the rise and fall of the tide is materially lessened by the approaching change in the moon, when the change of the ebb, for instance, would be about 6 hours earlier. Then for a day or two it would have no marked flow, and the beginning of each ebb at this time would be practically at the same hour daily. This peculiar condition of things exists at or near the quarters of the moon. About 48 hours after these phases the flow of the ebb and flood becomes more decided, 1 hour earlier or later, and continues so until several days after the period of greatest fluctuations, when all these features are again repeated and with the strongest uniformity, so much so that during the period of time covered by the survey, several months, the ebb always began from 10 a. m. to about 3 p. m. and the flood some 12 hours later. These peculiar variations give the discharge at the gorge (referred to below) a greater duration of erosive power than over areas south of this.

INFERENCES TO BE DRAWN BY COMPARING RESULTS OBTAINED IN SURVEY OF 1890 WITH THOSE OF OTHER SURVEYS.

Beach lines.—For authentic surveys we can not go farther back than the Coast and Geodetic Surveys of 1856. At this time we find the shore line extending continuously

Digitized by Google

from Fort Barrancas past the present entrance of the lagoon (see plan No. 2), and extending from a point in front of Fort McRee to the southwest very uniformly with the shore line of other surveys. At this time the lagoon entrance was some 4 miles to the southwest, not shown on the plan here referred to. Between the dates 1856 and 1881, this shore line, as it had evidently done for years previous, continued to recede until the narrow neck just north of McRee was worn away, and at this point the lagoon entrance formed. This erosion was due to two causes, which evidently exist here to-day: First, the impingement of the strong ebb current upon the shore in this locality, which rolled the beach sand along itself and distributed it over localities to the south and southwest of the harbor entrance. Second, during favorable winds, an inward or forward movement of sand by wave action. This latter force evidently filled the large pocket in the 1856 shore line, again north of the present lagoon entrance. South of Fort McRee the shore line between dates 1856 and 1881 receded a distance varying from 250 feet in front of McRee to some 2,000 at points south of this. This was due to the same cause which has caused the shore line to advance after the jetties at McRee had been commenced, and the beach line at this point rebuilt, viz, from wave action, approaching the shore obliquely; this carried the sand into the harbor entrance, its progress depending upon whether the wave action, favorable to accomplich this, occurred during a flood or ebb tide; of course the inward movement was greatest during a flood. When this sand had reached a point in front of McRee, or immediately inside of this, where the direction of the shore offered shelter, its inward movement became more slow during a flood and was finally lodged along this beach, from which locality, when the wave action became less favorable, or null, the strong ebb currents again picked it up and took it seaward in the direction of its flow, which would not follow the shore line after McRee had been passed, and distributed it over areas south and southwest of the harbor entrance. After the shore line near McRee commenced to advance, owing to the jetties, the beach line south of this point began to rebuild, and naturally so, for if these jetties offered a certain shelter or obstruction to the sand moving inward their influence would extend beyond their immediate vicinity, and over that extent the same result would be accomplished. That it advanced more in other localities than in the immediate vicinity of the jetties is due to the fact that the force opposed to a rebuilding of the shore line at McRee is evidently greater than at points south of this. As I will refer to this in another part of my report it is not thought necessary to say more here than is needed to account for the change in the beach lines. The shifting of Santa Rosa beach will be also left for that part of the discussion.

Soundings.—The result of the soundings as shown on plan No. 2, indicate that the deep curves have advanced from the western beach between 1881 and 1890, while a comparison between surveys of 1856 and 1881 show that over this same area they had an opposite movement; in fact, as seen on plan No. 2, between 1822 and 1881, this movement was to the westward. South of McRee and southwest of the harbor entrance the deep curves have moved to the south very slightly, or, as it might be expressed, approached the shore in this locality. Directly in front of Santa Rosa Head the deeper curves have approached the shore since 1881, while the more shallow ones show no decided movement, are vacillating, and correspond somewhat closely with the curve movement in front of the Pensacola light.

It will be observed that between 1856 and 1881 the 24-foot curve on the west side, and inside the entrance proper, approached the shore corresponding with the recession of the beach line, and that this curve, on the opposite side of the harbor, had a similar movement, or, that they have moved parallel with each other, keeping the cross section of the entrance constant, and since 1881, or since the time that the beach line near McRee has been held, that the deep curves on this side have advanced, forcing back or to the eastward the similar curves in front of Santa Rosa, or the conditions again adjusting themselves to the discharge from this parallel shifting of curves, it is evident that the present cross section at the gorge is the least that the tidal discharge will admit of, and that there will be a scouring of material, such as is found here, whenever the cross section does not greatly exceed that at the present entrance.

A comparison of the curves in the vicinity of the middle ground shows that there has been a decided movement of this shoal to the southwest, or in the direction of the ebb flow, causing a marked shoaling of the inner bar channel. The area of East Bank remains practically constant, also the area of Caucus Shoal. Where the deep curves have been forced into Caucus, on the harbor side, it has had a corresponding growth on the sea side. It will be noticeable, however, that the movement of the deep curves into Caucus, where the strong ebb strikes it, was previous to 1881, and while the deep curves and shore lines were moving to the westward, at and inside the harbor entrance. Had this shifting of the harbor entrance been allowed to continue, naturally and surely, the deep curves would have entered more into Caucus with a corresponding growth, however, of the shoal to the south. I make this statement to show that it was not, in my opinion, the force of the ebb that has

Digitized by Google

caused the 24-foot curve to encroach upon Caucus between 1856 and 1881, but rather that this was due to a change in the direction of the ebb flow, caused by, and corresponding to, the movement of the harbor entrance to the westward between the same dates. In other words, a similar line of reasoning which shows that the McRee jetties have caused the beach line on the south of them to advance over miles of extent, would show that the deep curves along the harbor side of Caucus would have a movement corresponding with the recession of the deep curves and beach line in the neighborhood of Fort McRee. Between the dates of 1881 and 1890, and when there was no movement of the harbor entrance to the westward, it will be seen that this cutting of Caucus Shoal has ceased. Unfortunately the number of soundings plotted on the Coast Survey charts of 1856 and 1881 will not admit of following out the many irregularities of these curves, as will the number of soundings taken in 1890; if the chart of 1881 admitted of this, I am of the opinion that the 24-foot curves of 1881 and 1890 in the locality of Caucus (on the harbor side) would very closely correspond, or, that as long as the western beach lines and curves of the harbor entrance remain fixed, as they now are, that there will be no perceptible movement of the deep curves to the south when the strongest ebb strikes Caucus.

VELOCITIES.

These were observed through periods of greatest influx and reflux, it being thought more desirable to become familiar with the duration and force of the strongest tidal currents than with the more feeble ones. On plan No. 3 are represented the directions and velocities of a normal excessive influx and reflux, and on the diagrams of tidal velocities the total of the observations taken. On the diagrams the top represents magnetic north, and the scale of 1 inch = 2 feet per second will give the velocity in feet per second. The small figures, 1, 2, 3, etc., represent simply the number of the observation; on the plan and diagram, to avoid confusion, only one-half of the observations are represented. Therefore the number of the observation on these represents also the number of hours the tide had been running at the time the observation was taken. On plan No. 3 the velocities represented are mean velocities; the diagrams will give the surface and bottom as well. The fluctuation of tide, as indicated on the gauge during velocities represented on plan No. 3, was 1.3 feet for the ebb and 1.1 feet for the flood.

From reference to this plan it will be seen that the ebb currents are much stronger than the flood; that the former have, during periods of a strong flow, a southeasterly direction immediately in front of the harbor entrance, while the directions east and west of this have a more easterly and westerly flow, respectively. The ebb tendency is eastward, and no doubt a few miles offshore would be found running nearly due east. In fact, 12 miles from the harbor entrance I have observed it running so, while in front of the harbor proper it was as represented on diagrams. The first observations taken at the beginning of an ebb are more easterly than the later and stronger ones, and almost invariably as the ebb begins to slacken the direction of the flow is more easterly than the ones intermediate between these and the ones first taken. This would indicate, it seems to me, a flood approaching from the south. This at station No. 1, entrance buoy, is more prominent. The flood velocities taken were found to be stronger directly in front of the harbor than at stations east of this. Station No. 9, for instance (East Bank Buoy). The ebb approaching the entrance from the bay increases in velocity until the gorge is reached, where it has its greatest velocity. As it issues from the harbor, owing to the rapid increase in cross section, it is diffused over a greater surface, has greater frictional resistance, and a consequent decreasing velocity. This decrease, however, does not become strongly apparent until the harbor side of Caucus Shoal is reached; the impulse carries it a certain distance and retarding influences are not so perceptible; but from this point the rapidly increasing frictional resistance causes a decided slackening of the ebb velocities. (See stations Nos. 3, 2, and 1.) At 2 and 1 they are not only slower, but less definite in direction. Between velocities at stations Nos. 4 and 5 the same can be observed.

There is little use in comparing the ebb and flood velocities in order to ascertain the direction of the resultant force. A glance at plan No. 3 or the diagrams will clearly show that it is strongly in favor of the ebb. On this plan the ebb was taken 2 days before full moon, the flood on the day that the moon fulled; wind, similar; aiding the conclusion that the resultant is outward if the fact that the duration of the ebb is less than that of the flood, notwithstanding that the former discharges the influx plus the amount of fresh water stored during this period. A further history of the resultant is written in the fact that all the shoals in the harbor entrance have their longer axis in the direction of the ebb flow. The movement of the curves and beach lines to the westward, from 1822 to 1881, this being the earliest history that we have of this evidence, indicates clearly enough what effect the ebb currents have upon sand in the locality of the gorge. I say ebb force because there is no evidence what-

Digitized by Google

ever that the enormous amount of material that has been moved from the locality mentioned has been lodged inside the harbor by the flood.

That portion of the ebb discharge passing through the gorge over the main ship channel is drawn towards the southeast and obliquely across Caucus Shoal. The impetus that it has received while passing out of the harbor, and the fact that the additional frictional resistance, owing to an increasing cross section, has not had time to exert a sufficient influence to reduce the velocity below that which would be expected to move sand, when the harbor side of Caucus Shoal is reached, gives rise to the question, why its effects are not more noticeable upon deepening this shoal. As stated above we have here but one ebb and one flood during each 24 hours. Naturally, during new and full moon we have our highest tides, and during periods just previous and just after the tide is increasing and decreasing, respectively, so that between the phases of the moon referred to, the tidal discharge, owing to a small tide, is too feeble to have any effect upon sand movement over the inside expanse of Caucus Shoal. Comparison between velocity diagrams June 24, just before first quarter, and that of June 30, just before full moon, better illustrates this. It may be remarked that frequently during first and last quarter the currents at the stations selected were so undecided that they were not taken; but at nearly all times there is a decided flow through the gorge. This is evidently due to the narrow section. Again, even during the highest tides the duration of rapid flow through the gorge greatly exceeds that at the stations selected. No doubt, however, that some of the velocities observed on Caucus would move sand, but the number of consecutive days that such a condition exists, during each month, is comparatively small. The condition of currents capable of moving sand at the gorge is much longer, not only more hours per day, but more days per year; therefore, when the current velocities have become so slack in the vicinity of Caucus that they can not move sand there is a force capable of doing this at the gorge. This force continues to roll down, in the vicinity of Caucus, some quantity of sand, which is finally lodged there, and which, probably, the current force in the neighborhood of Caucus carries on when the conditions have become favorable for it to do so. But before these strong currents in this locality have had time to undo what the stronger ebb currents, passing out of the gorge, had done while the velocities over Caucus were more feeble, they have again become too slack to offer any erosive power, and the lodgement of sand again continues.

The sand which the stronger ebb currents lodge on Caucus during periods when they have not the force to carry it further is picked up principally at and just outside the harbor entrance. To illustrate, during flood and when the wave action along the western shore was favorable for moving sand inward I have seen great quantities of sand just in front and about the south jetty. During one flood I have seen a sufficient amount of sand lodged here to cover completely concrete blocks 4 feet in height. A few hours after the ebb, however, this sand would be all taken seaward again, and the blocks referred to uncovered to the foundation, upon which not a particle of sand would remain. It is evidently this greater velocity force at one locality over another, causing a constant give-and-take method, that sustains the stability of Caucus Shoal. Evidently, if the velocities over this shoal had power to move sand its crest would have been lowered during the past 34 years, were there not forces employed in attacking the result of some other force. Might we not say that if the currents passing over Caucus have the power to move the sand of which it is composed that its present crest height would never have been reached? That the velocity forces passing through the gorge have produced these results is beyond question. A glance at plan No. 2 will show this. These changes at the gorge are due to the stronger and more continuous force than exists over Caucus, and I do maintain that in such a case as ours the conditions existing at the gorge transferred or extended to Caucus would alter the depths on this shoal and lead them in a tendency towards those found at the gorge.

The current velocities passing over the middle ground on that portion of the ebb discharge east of the ship channel continue seaward over the outer bar. This portion of the current comes in contact with and picks up the sand brought into the harbor along the outer Santa Rosa Beach, and distributes it over the Middle ground, causing a constant growth of this shoal to the southward. These currents passing over the outer bar have, before they reach this point, become so feeble that they have dropped, or ceased to move sand, and do not make any change in this bar.

Borings.—These were taken to a depth of 29.3 feet on Caucus and to a depth of 30.3 below mean low water on the inner and outer bars. Samples of these borings are sent herewith, the sample being the last sand taken up. The material obtained through the entire core of each boring indicates that these shoals are composed of sand similar to that found along the shores here. During the process of boring on the Caucus the water brought up in the pump was quite black, and seemed to indicate that the pipe had passed through a strata of dark clay, but the action of the pump so churned it that the stratification of this dark material, if it has any, could

Digitized by Google

not be determined. The nature of the material confirms the opinion that it can be either dredged or moved by current force to a depth of 30 feet below mean low water.

As engineering questions similar to these involved are frequently more readily solved when the causes of formation and progress of bars are well understood, I venture to submit here what, in my opinion, seem to be the causes which lead to the formation of the shoals at the entrance to this harbor. These conclusions were reached after a careful study of the natural tendencies and forces which exist here to-day, and by applying them to this locality when the conditions, such as entrance to harbor, beach lines, and curves, were probably entirely different from those which we find at present. It can not be well argued for a moment that the shoals in this harbor were not the result of natural forces and conditions here existing. That area over which winds, currents, and waves have had control is well defined by the characteristic beach sand, containing particles of shells, and it is not a wild assertion to state that there was a time when the entrance to this harbor had no shoals or bars. Their geological formation is so entirely different from that of the surrounding country that they must have had a distinctive origin, and came from causes not at all connected with the earlier geology of the locality. If this be true we must conclude that these shoals are the outgrowth of conditions which have existed and do exist here to-day, altered somewhat by the results which they have accomplished. Admitting this last we are narrowed down to the fact that the bars in question have been created by the stronger of the two forces either acting inward or outward.

It is argued that harbor entrances like ours are moving gradually to the westward. The only truth, I take it, in a general assertion of this kind, is that, if it be a fact, each harbor entrance has local conditions which produce such a movement. I make this reference because I do not wish to have it understood that, while I admit that our harbor entrance has moved westward, there has been a general law for this other than what can be observed in this locality.

Unfortunately the earliest survey of our harbor entrance goes back only to 1822, or 68 years, which is a period of time of but little value when we begin to compare results which are produced as slowly as that of the formation of bars or the shifting of the entrance. We do know, however, that possibly for all time the rise and fall of the tide was about the same, that the storm winds were from the southeast and the prevailing winds were from the southwest, that the most rapid flow was in the direction of the ebb, or conditions similar to those we find to-day. The soil of Santa Rosa Island and that of the mainland on the north side of Santa Rosa Sound is so different it is evident that the island dates from a different period of time from that of the mainland, and referring to the growth of this island only in as far as it deals with the harbor entrance, there is no doubt, in my mind, but that the head of Santa Rosa was at one time at or near the present quarantine station, or just south of Deer Point. Possibly, and in all probability, at such a time the harbor entrance did not extend from quarantine station to near the present McRee Beach line, but the sand, which for all time has been moving into the harbor from the southwest, had built the beach line far to the eastward, and no doubt the harbor entrance then was on a line joining Deer Point (see Coast Survey maps) with the present navy-yard. To-day the wave action along the outer side of Santa Rosa Island moves the sand toward the mouth of the harbor. It has evidently been doing so for all time. As the sand is moved forward to a point called the head of the island, it comes in contact with another force, the ebb current, which, in a word, disputes it entrance, and the result is that the growth of sand is in the direction of the resultant of the wave action on one side and the ebb flow on the other, or to the westward. If this sand was controlled by the wave action and the flood current the lodgment of sand at this time would have been a deposit from Deer Point to Redfish Point, and the closing up of Santa Rosa Sound. This growth continued to the westward until the contraction had become so great in the harbor mouth that the westward shore, or side, was attacked by the growth of Santa Rosa forcing the currents upon it, and here was the cause and beginning of Caucus Shoal, and until then this harbor entrance, in my opinion, had no shoal in the vicinity of Caucus. Referring to plan No. 2, it will be seen that between the years 1856 and 1881 Santa Rosa had a growth, as above described, of some 500 feet; but its slow growth in these years should not be compared with that of former ones when its head was further to the east, and its growth did not possibly depend upon the erosion of the opposite beach. Therefore, as stated, the first lodgment of sand on Caucus Shoal was when the advance of Santa Rosa from the east caused the currents to attack the west side. This contraction not only increased the velocity of the ebb flow through the entrance, but also changed its direction, creating a condition more favorable for the erosion of the western shore. The deflection of the ebb current to the southeast at this time was not, probably as sharp as it now is (I refer to the locality of the entrance only), but passed out about south. This ebb flow, after the contraction had reached a point mentioned, picked up from along the

Digitized by Google

west side, as it is doing to-day, the sand moved into the harbor by waves from the south, and carried it in the direction of its flow. Its force was not entirely expended upon this shifting of the sand brought into the harbor almost daily, but also in eroding the west beach, shoving the deep curves to westward. On Plan 2, a comparison between 1822 and 1881 will show this. After the harbor entrance was passed, the decreasing velocity dropped the sand, or more sluggishly rolled it along, and as the greater part of it was carried by that part of the discharge coming in contact with the western shore, it was distributed by the discharges having the most southerly and westerly flow. As the recession of the western beach continued the discharge at the mouth had its deflection southeast more quickly, and the sand then picked up, or rolled along, was lodged more to the south. We see, therefore, that the natural deflection of the current at the entrance was first favorable to starting the root of Caucus Shoal, and as it was made to deflect more to the south by what it had already accomplished in the vicinity of McRee, that it was favorable for continuing the building of Caucus in the direction of its present greatest axis. This growth continued until its crest had reached a horizontal stratum of water having a velocity sufficiently strong to hinder its higher growth, and flattening or leveling has consequently followed. Both the extent and flatness of this shoal indicate, beyond a doubt in my mind, that the forces existing here, as far as raising or lowering the crest of Caucus is concerned, have reached a condition of equilibrium, and that this shoal will now have growth in area but no alterations in crest height.

Confirming this theory of the origin and growth of Caucus Shoal are the facts:

First. That it has its longest axis in the direction that would be favorable to such a condition of things; that is, there was a time when Santa Rosa grew more rapidly than the western beach receded, and this narrowing of the entrance caused an increasing velocity through the gorge, thus creating a force capable of carrying sand farther from the entrance, and forcing the outer end of Caucus, as it grew, to the south.

Second. The enormous quantity of sand which moves into this harbor along the western beach can only be well understood by one who has remained constantly here. It is sufficient to have made not only a decided shoaling of the harbor inside during the many years while these supposed changes have been going on, but one that would have been noticeable from one period of survey to the other. But this shoaling has not taken place; Caucus therefore must have been the dumping place for this sand, as well as for that quantity indicated by the recession of the curves. (See Plan No. 2.)

Third. That during a period covered by authentic survey the growth of this shoal, when at all, has been extended to the southward.

Fourth. That it has its greatest width nearest the harbor entrance.

All these observations and actual changes, as represented on maps, would be opposed to the theory that this formation was due to any irregularities in the flood flow, and that the sand, of which it is composed, has been forced from deep water by storm waves.

If this line of reasoning be true, it seems to me that if any part of Caucus was removed, that force which originally built it would again step in and claim its own, and that if the currents crossing Caucus at a depth of from 12 to 16 feet can not lower its crest, they can not keep open a channel dredged to a greater depth, and this, too, after an additional frictional resistance.

EAST BANK AND MIDDLE GROUND.

When Santa Rosa had advanced from the east to a point marked now by the root of East Bank Shoal its further advance must have been controlled to some extent by the movement of the opposite or McRee shore to the westward. At this juncture the sand that was brought along the outward beach of Santa Rosa was not permitted to lodge, but was picked up by the ebbs and deposited in the direction of the longest axis of East Bank; or, in other words, the cross section had become adjusted to the discharge and the entrance could close no more, or only so fast as the west shore receded. The erosion of this shore was progressing, but no doubt very gradually, at this time, and proceeded so until a very soft formation was reached, possibly a small lagoon or lake, such as is found along this coast, and for the next period of time this shore receded very rapidly, and the sand that was brought to the head of Santa Rosa was permitted to remain, and this point grew to the westward in pace with the recession of the west shore, and consequently East Bank has been left, as far as the entrance is concerned, an isolated shoal. Santa Rosa continued to extend until its now rapid progress was again arrested by the fact that the west shore refused to fall back as rapidly as it had been doing, and the sand was again picked up from its head by the ebb and taken seaward in the direction of the present axis of the Middle Ground, and the formation of this shoal began. The more slowly the western beach and curves receded the more rapidly this shoal grew; for this reason

Digitized by Google

its growth has been more marked since the construction of jetties than at any other time.

Between 1881 and 1890 Santa Rosa, it will be observed, has been driven back, evidently due to the works on the other side. I do not think that it will fall to the eastward much farther; or no longer, at least, than while the gorge section is becoming adjusted to the discharge; but it can not be said, I think, that this adjustment will arrest the growth of the Middle Ground, because this will always be the dumping place for the sand brought into the harbor by wave action along Santa Rosa Beach so long as the condition of the McRee side resists the erosive action of the currents.

Forwarded herewith are plans: *

No. 1, showing beach lines of 1890, with channels and shoals outlined by 3-foot contours, and profile of inner and outer bars.

No. 2, showing beach lines and curves of 1856, 1881, and 1890, and curves of 1822 and 1847.

No. 3, showing direction and velocity of currents.

Also 10 sheets "Diagrams of Tidal Velocities," and 3 sheets "Tabulated Tidal Velocity Observations."

Very respectfully submitted.

J. E. TURTLE,
Assistant Engineer.

Capt. PHILIP M. PRICE,
Corps of Engineers, U. S. A.

REPORT OF BOARD OF ENGINEERS UPON IMPROVEMENT OF PENSACOLA HARBOR, FLORIDA.

UNITED STATES ENGINEER OFFICE,
Pensacola, Fla., July 16, 1891.

GENERAL: The Board of Engineers constituted by Special Orders No. 5, Headquarters, Corps of Engineers, January 17, 1891, for the purpose of considering and reporting upon the improvement of Pensacola Harbor, Florida, made a personal examination of that harbor in February, 1891, and has now the honor to submit the following report:

1. DESCRIPTION.

Pensacola Bay is a body of deep water separated from the Gulf of Mexico by a low, narrow spit of sand about 50 miles in length, known as Santa Rosa Island.

The bay is connected with the Gulf of Mexico through Santa Rosa Sound, Choctawhatchee Bay, and East Pass at the eastern end of Santa Rosa Island, and through the main ship channel which lies between the western end of Santa Rosa Island and the site of Fort McRee on the mainland opposite. The latter entrance is properly the only connection of the bay with the Gulf. The width of entrance at the gorge is 4,410 feet, with a mean depth of 27.3 feet, and a maximum depth of 47.3 feet.

The area of Pensacola Bay is about 172 square miles, and there is a safe land-locked anchorage, with depths of 28 feet and upward, of about 6,425 acres. A good 30-foot channel exists from the city of Pensacola to the bar.

Immediately outside of the entrance, and separating the inner and outer deep-water curves, are located Caucus Shoal on the southwest, Middle Ground Shoal slightly to the east, while still further to the eastward lies the East Bank Shoal.

Caucus Shoal, the most extensive of the three, springs from the main-

* Referred to Board of Engineers on Pensacola Harbor and submitted with report of the Board (see page 1733).

Digitized by Google

land under the sheltered point of Fort McRee beach, its longest axis (9,600 feet) extending in a southeasterly direction. The outer portion of the shoal, over which passes the strongest ebb currents, has its flattest slope on the harbor side. Middle Ground Shoal, which is separated from the western end of Santa Rosa Island by a swash channel with a minimum depth of 10.4 feet, extends about 6,000 feet in a course varying from southeast to south by east, uniting at its extremity with the outer end of Caucus Shoal to form the inner bar. The axis of the Middle Ground Shoal is parallel to that of the deep-water channel. Its slopes are abrupt on the harbor side, indicating the controlling force of the ebb in governing its growth and maintenance. East Bank Shoal lies about 7,000 feet east of the harbor entrance, and extends about 6,550 feet in a southwesterly direction, where it unites with Caucus Shoal to form the outer bar. The seaward slope of this shoal, which faces the storm quarter, is flat; the harbor side quite abrupt.

The main ship channel passes out of the harbor on a curve, practically midway between Santa Rosa Island and the mainland opposite, turns sharply to the eastward at a point 4,350 feet from the gorge where it crosses the inner bar, changes its course to south by east at a point 4,550 feet further on, and crosses the outer bar to the sea.

A swash channel passes between the western end of Santa Rosa Island and the Middle Ground. The general direction of the western end of Santa Rosa Island in the vicinity of the entrance is east-southeast, and of the main shore to the west of the entrance west-southwest.

2. HISTORY OF IMPROVEMENT.

The improvement of Pensacola Harbor was begun by the United States in 1878, by the removal of certain wrecks which obstructed the channel. In 1881 a project for the improvement of this harbor was formulated by the Board of Engineers for river and harbor improvement. It provided for the protection of the shore line near Fort McRee by spur jetties, and for dredging a channel 300 feet wide and 24 feet deep across the inner bar.

In accordance with the terms of this project some dredging was done between 1881 and 1886, there having been obtained in the latter year a channel 120 feet wide and 24 feet deep across the inner bar. Between 1881 and 1887 two jetties of piles and brush were constructed near Fort McRee, but owing to their exposure to the teredo and to storms, not more than 25 per cent. of them remained in 1888. They were then rebuilt of stone and concrete. This work, which, so far, has been entirely satisfactory, was completed in April, 1890. No work has since been done. There was, at the date of the last survey, a low-water depth of 19.6 feet over the inner, and 22.1 feet over the outer bar.

3. TIDES.

On the western coast of Florida from Key West to St. Marks the tidal wave entering through the Florida Straits appears to dominate. At all points on this part of the coast there are, as on the Atlantic coast of the United States, two tides during each lunar day, the duration of each ebb and flood varying little from 6 hours.

High water takes place at Key West 9 hours 30 minutes after lunar transit and thence proceeds northward along the coast line as follows:

Egmont Key, 11 hours 36 minutes; mean rise and fall, 1.3 feet.
Bayport, 13 hours 03 minutes; mean rise and fall, 2.4 feet.
Cedar Keys, 13 hours 28 minutes; mean rise and fall, 2.5 feet.
St. Marks, 13 hours 58 minutes; mean rise and fall, 2.5 feet.

Digitized by Google

Digitized by Google

MONTHLY INEQUALITY OF TIME AND HEIGHT OF HIGH WATER.
AT FORT PICKENS.
ENTRANCE TO PENSACOLA BAY.

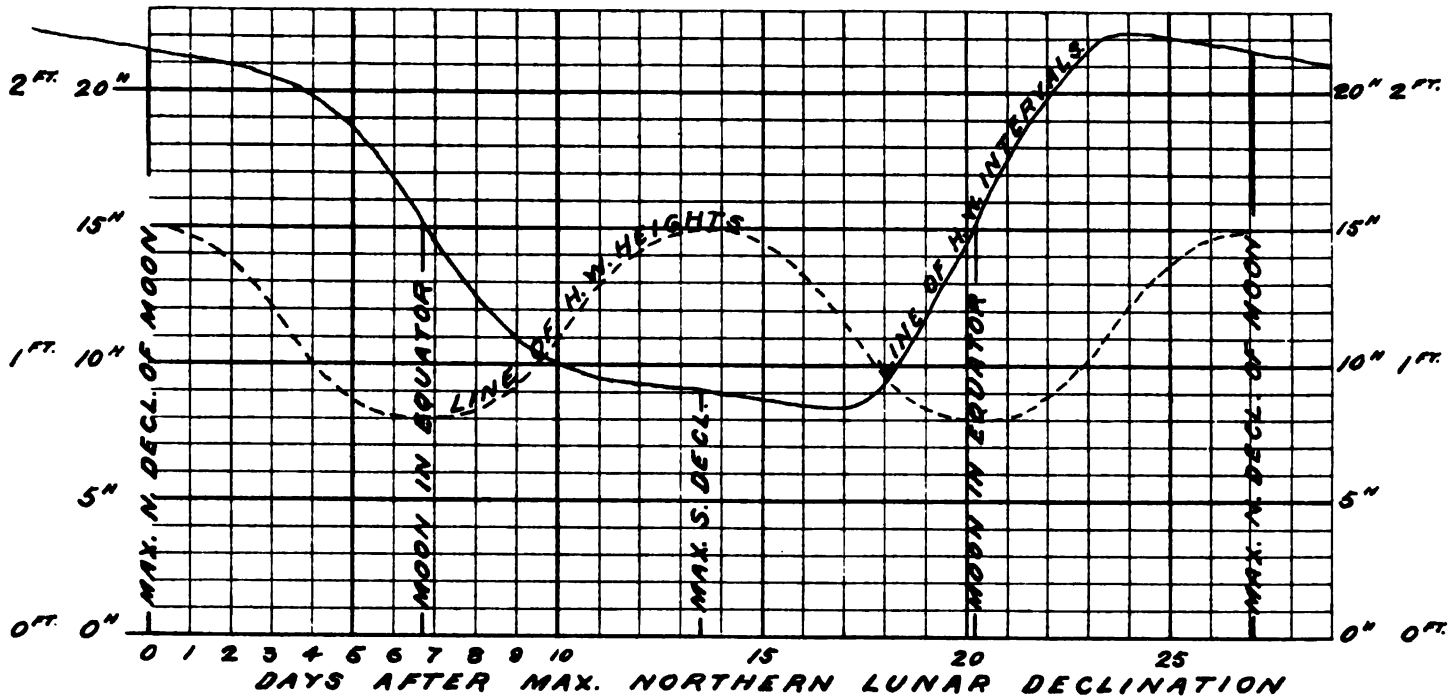


Photo-Lith. by A. HOEN & CO., Balto., Md.

Eng 91

Digitized by Google

The apparent derivation of the Gulf tides from those of the North Atlantic coast, and the conditions of similarity therewith appear to prevail as far as James Island. A short distance west of that island, at the Apalachicola entrance to St. George Sound, a radical change has taken place. From Apalachicola westward and southward along the entire Gulf coast concerning which information is available there is ordinarily but one tide each lunar day. When, however, the moon is in or near the equator two small tides make their appearance, but not regularly. The inequality of the time and height of high water is not a half-monthly one governed by the solar tidal component, but a monthly one governed by lunar declination. During maximum northern declination of the moon there occur the longest, and during a maximum southern declination the shortest lunitidal intervals. During maximum southern and northern declination of the moon are found the highest high waters and during the time when the moon is in or near the equator the lowest high waters.

Such, in general, are the conditions which prevail at the entrance to Pensacola Bay. On the diagram herewith will be found a graphical representation of the monthly inequality of the time of high water, which will serve to illustrate the foregoing description.

The mean rise and fall of the tide throughout Pensacola Bay is stated by Mr. Turtle in his report to be 1.4 feet, and the entire area of the tidal basin is given as 172 square miles. The duration of ebb flow is given as 11 hours and 48 minutes. From these data and a stated volume of fresh-water flow 2,405,001,600 cubic feet per 24 hours there results an ebb volume of 9,249,318,815 cubic feet. In this estimate it appears to be assumed that during each ebb tide there is voided a volume extending all over the bay and having a uniform thickness of 1.4 feet, an assumption which is doubtless incorrect. It is not probable that the exact stage of high and of low water, respectively, exists all over the bay simultaneously with the change of current at its mouth from flood to ebb and from ebb to flood, and unless it does the height of the mean tidal prism is not everywhere as great as the mean rise and fall of tide at the entrance.

The data relating to this subject, consisting of tidal observations made in 1887 and of current observations made in 1890, are insufficient to settle the questions definitely, and Mr. Turtle's computation of the ebb volume must therefore be looked upon as an approximate rather than as an accurate determination.

It appears, moreover, that to the estimated volume of the tidal prism the entire daily amount of fresh-water flow has been added in order to obtain the total ebb discharge. This is obviously incorrect, the fresh-water discharge which occurs during time of flood current at the mouth being already contained in the tidal prism. With these corrections the ebb discharge becomes:

	Million cubic feet.
1. Tidal prism, 172 square miles in area and 1.4 feet average height	= 6,713
2. Fresh-water flow during 11 hours 48 minutes (time of ebb flow)	= 1,182
Total ebb discharge at harbor entrance	7,895

Mr. Turtle states that the "effective tidal flow" on the ebb lasts 7 hours 15 minutes, and he estimates the discharge during that time at about 78 per cent. of the entire volume, or at about 6,158 million cubic feet, which gives a discharge of 236,000 cubic feet per second, with a resulting mean velocity of nearly 2 feet per second.

Digitized by Google

During heavy storms the tide has been observed to rise 5 feet, and tidal discharges during a single ebb of 12,000,000,000 cubic feet have been reported, while during the prevailing northerly winds the discharge is much less than the average.

4. WINDS, STORMS, AND WAVES.

The following tables, compiled from the Signal Service reports, show the average frequency of winds at Pensacola, for different months during the 4 years ending December 31, 1884, and the monthly wind movement, in miles, during the same period:

PENSACOLA, FLORIDA.

Monthly average frequency of winds for four years, 1881 to 1884.

Months.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calms.	Prevailing direction.
January	93	65	60	44	38	18	6	34	14	N.
February	54	30	43	86	37	31	15	31	12	SE.
March	50	23	18	60	72	59	29	53	8	S.
April	49	19	29	51	82	67	25	32	6	S.
May	45	20	12	75	103	62	17	36	2	S.
June	24	15	20	39	80	118	22	29	18	SW.
July	26	29	14	31	85	105	44	25	13	SW.
August	26	42	29	38	107	63	27	31	9	S.
September	34	62	49	78	74	17	9	21	16	SE.
October	60	80	47	67	46	29	6	26	11	NE.
November	111	82	49	37	31	12	5	24	9	N.
December	84	83	52	32	24	26	23	30	18	N.
Four years	656	550	422	638	779	607	228	372	131	S.
Per cent	15.0	12.5	9.6	14.6	17.8	13.8	5.2	8.5	3.0	.....

Monthly wind movement, in miles, for four years, 1881 to 1884.

Months.	1881.		1882.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
January	5.214	N.	5.960	S.
February	6.781	SE.	5.590	SE.
March	7.308	NW.	5.938	S.
April	6.279	SW.	6.306	S.
May	5.432	S.	7.155	S.
June	5.435	SW.	5.957	SW.
July	5.100	S.	4.511	S.
August	6.412	S. and SW.	4.525	S.
September	5.444	SE.	5.081	NE.
October	5.932	NE.	5.532	N. and NE.
November	5.625	N.	5.346	N.
December	6.779	NE.	5.397	N.
Total	71.741	S.	67.298	S.
Average	5.978	.....	5.608	.....
Maximum velocity	40		50	
Direction and date	SE., Feb. 6; SE., Feb. 7; SW., Feb. 27; S., Aug. 3; SE., Nov. 6; SE., Dec. 25.		N., September 9.	

Digitized by Google

Monthly wind movement, in miles, for four years, 1881 to 1884—Continued.

Months.	1883.		1884.	
	Total movement.	Prevailing direction.	Total movement.	Prevailing direction.
January	4.553	N.	6.510	N.
February	4.780	N.	5.800	SE.
March	6.002	S.	6.552	S.
April	6.548	S.	6.325	S.
May	6.089	S.	5.344	SW.
June	5.755	SW.	5.401	SW.
July	5.336	SW.	5.218	SW.
August	4.631	S.	4.385	S.
September	4.573	S.	3.964	SE.
October	5.830	SW.	4.822	NE. and SE.
November	5.314	N.	4.597	N.
December	4.231	N.	6.294	E.
Total	63.642	S.	65.212	S.
Average	5.303		5.434	
Maximum velocity	36		32	
Direction and date	E., March 24; SE., May 29		S., November 23.	

From the foregoing tables it will be seen that during the 4 years mentioned 24.2 per cent. of the winds observed have been from the east and southeast. The waves resulting from these should produce a westerly movement of sand along the coast. Nineteen per cent. have been from the west and southwest. These should produce an easterly movement of sand along the coast. Fifteen per cent. have been from the north and 17.8 per cent. from the south. The former being offshore and the latter onshore winds ought to have no appreciable effect in the transportation of sand along the shore.

Although the prevailing winds are from the south, their direction during the great storms which have taken place has been generally from the east to the southeast. The storm waves correspond in direction with the storm winds, and during heavy storms waves rising to a height of 9 feet above mean low water have been observed. It is to be regretted that the wind records are so meager, and that the observations were made in the city of Pensacola instead of at the harbor entrance.

5. CONTROLLING FORCES AND MOVEMENT OF SAND.

An examination of the harbor entrances from Mobile Bay to St. Joseph indicates a general resultant sand movement toward the east. That there is a local sand movement towards the west along Santa Rosa Beach is undoubted, but it may be possible that here, as at points along the South Atlantic coast, there exists in one direction a resultant movement controlling the general direction of the outer bar channel, while there exists near shore a decided local movement in the opposite direction.

From the table of wind movement previously referred to it is seen that the greatest movement takes place in March, April, and May, and that the prevailing direction during that time is southerly. During the 4 years covered by the table, winds from the southeast, south, and southwest have occurred in those 3 months 631 times, and from all other directions during the same period 474 times. The prevailing direction of high winds and of the wave motion produced by them is therefore at right angles and the wave crests parallel to the general trend of the shore line. Near the entrance, however, where the coast line gradually

Digitized by Google

curves inward, the waves driven before southerly winds strike both shores obliquely and set in motion great quantities of material which finally settle on the sides of the paths traversed by the outgoing and incoming currents. It is probable that the Caucus Shoal was formed in this way.

The Middle Ground and East Bank may owe their existence to the same causes, as indicated by Mr. Turtle, or they may be obstructions which, on account of their hardness, the currents could not scour away.

While the high southerly winds thus act as bar-building agencies they, at the same time, serve to drive the water into Pensacola Bay, and thus to increase the tidal prism. Their tendency to advance the shoal into the channel is, therefore, met on the other hand by the stronger scouring currents of the ebb produced by them. It is probable that under these circumstances a deeper channel would be maintained over the bar if the ebb and flood currents did not move in different paths.

Mr. Turtle gives his views of the formation of the shoals at the harbor entrance as follows:

The first lodgment of sand on Caucus Shoal was when the growth of Santa Rosa from the east caused the currents to attack the west side of the entrance.

* * * * * * *

The ebb flow, after the contraction had reached a point mentioned, picked up from along the west side, as it is doing to-day, the sand moved into the harbor from waves from the south and carried it in the direction of its flow.

* * * * * * *

After the harbor entrance was passed the decreasing velocity dropped the sand or more sluggishly rolled it along, and as the greater part of it was carried by that part of the discharge coming in contact with the western shore it was distributed by the discharges having the most southerly and westerly flow.

* * * * * * *

We see therefore that the natural deflection of the current at the entrance was first favorable to starting the root of Caucus Shoal, and as it was made to deflect more to the south by what it had already accomplished in the vicinity of McRee, that it was favorable for continuing the building of Caucus in the direction of its present greatest axis.

* * * * * * *

All these observations and actual changes, as represented on maps, would be opposed to the theory that this formation was due to any irregularities in the flood flow, and that the sand of which it is composed has been forced from deep water by storm waves.

* * * * * * *

When Santa Rosa had advanced from the east to a point marked now by the root of East Bank Shoal, its further advance must have been controlled to some extent by the movement of the opposite or McRee Shore to the westward. At this juncture the sand that was brought along the outward beach of Santa Rosa was not permitted to lodge, but was picked up by the ebb and was deposited in the direction of the longest axis of East Bank. Or, in other words, the cross section had become adjusted to the discharge and the entrance could close no more, or only so fast as the west shore receded. The erosion of this shore was progressing, but no doubt very gradually at this time, and proceeded so until a very soft formation was reached, possibly a small lagoon or lake, such as is found along this coast, and for the next period of time this shoal receded very rapidly, and the sand that was brought up to the head of Santa Rosa was permitted to remain and this point grew to the westward in pace with the recession of the west shore, and consequently East Bank has been left, as far as the entrance is concerned, an isolated shoal. Santa Rosa continued to extend until its now rapid progress was again arrested by the fact that the west shore refused to fall back as rapidly as it had been doing, and the sand was again picked up from its head by the ebb and taken seaward in the direction of the present axis of the Middle Ground, and the formation of this shoal began. The more slowly the western beach and curve receded the more rapidly this shoal grew; for this reason its growth has been more marked since the construction of jetties than at any other time.

Digitized by Google

6. CHARACTER OF BAR AND CHANGES.

Borings were made to a depth of 29.3 feet on Caucus Shoal and to a depth of 30.3 feet on the inner and outer bars.

These reveal the presence of sand to a depth of about 28 feet at mean low water and of sticky, slate-colored mud below that level. The thickness of the clay stratum was undetermined. The crest of the bar is composed of hard siliceous sand containing about 1 per cent. of carbonate of lime. The grains of sand found near the harbor entrance are somewhat coarser than those composing the crests of the shoals, there being contained of the latter 412,353 grains to 1 cubic inch. When allowed to fall through salt water, samples of this sand acquired final velocities varying from 1.06 to 4.54 inches per second, which are the velocities of the vertical currents required to keep the sand in suspension, and show with what ease the material, once in suspension, can be moved by water.

A detailed statement of the changes in the shore line and shoals which have taken place in this locality is given in the report of Mr. Turtle, dated November 19, 1890, and transmitted with the report of Captain Price.

There has been no marked alteration in the hydrography of the entrance within the period of time covered by authentic surveys, the present channel occupying about the position of that of 1822. The principal changes since the survey of 1856 are:

1. A southerly advance of the Middle Ground.

2. A slight growth to the southward and to the eastward of the Caucus Shoal.

The depth of water on the outer bar since the time of authentic surveys has remained constant at about 22 feet. Previous to the dredging done in accordance with the project of 1881 there was a depth of 19.5 feet across the inner bar. This was increased in 1886 to 24 feet, with a width of 120 feet. The growth of the Middle Ground has caused shoaling to take place in that channel, until there remains at present a low-water depth of 19.6 feet, which is practically that which existed prior to improvement. The depth of water on the three principal shoals has not changed.

7. COMMERCE.

The commerce of Pensacola for the calendar year 1890 amounted to about $5,000,000, the principal exports consisting of cotton, naval stores, timber, and lumber, and the imports of fruit and fertilizers.

Over 300,000,000 feet of timber and lumber were shipped during the year.

Pensacola's foreign sailing tonnage exceeds that of all the other Gulf ports combined, including New Orleans.

Col. W. D. Chipley, vice-president of the Pensacola and Atlantic Railway Company, in reports appended hereto, states that a movement is now fairly started through which Pensacola will export, in addition to the cotton, naval stores, and timber mentioned, coal and iron from the mines of Alabama, railroad, bridge, car, house, and ship building material, etc. He further states that Pensacola is beginning to send cotton goods, machinery, and Western produce of every kind to the Americas south of us, which shipments, he adds, will be largely increased under the policy of reciprocity.

After the deepening of the inner bar in 1881–1886 the commerce of the port was largely augmented and the class of vessels entering the

Digitized by Google

harbor much improved. Shoaling has since taken place, and during the past year vessels have been detained, after loading, from 1 to 3 weeks before being able to go to sea; a number of vessels went aground on the inner bar, while a large number were obliged to put to sea with incomplete cargoes. Owing to the increased commerce of the port the necessity for deep water is greater than before the first improvement was made. It is estimated that a reduction of from 8 to 20 per cent. in freight rates would follow an increase of the navigable depth to 26 feet.

It will be seen that Pensacola has better natural conditions for deep water than any other Gulf port. Existing railroads are extending their lines and new roads, projected or in process of construction, will afford ample facilities for communication with the interior. The importance of Pensacola from a military and naval standpoint has long been recognized, and considerations of defense as well as those governed by commercial necessities demand the improvement of the entrance to its harbor.

8. PLAN OF IMPROVEMENT.

The method of obtaining deep water across the bar at the entrance to Pensacola Harbor by dredging was tried between 1881 and 1886, there having been obtained in the latter year a channel 120 feet in width and 24 feeth in depth.

Although only 5 years have elapsed since then the growth of the Middle Ground and Caucus Shoals has been so rapid that the depth of water in the bar channel has already been reduced to that prevailing prior to the original improvement.

To obtain over the inner and outer bars by dredging a channel 2[illegible] feet deep and 300 feet wide will cost, in round numbers, $190,000, and will require an annual expenditure of $30,000 thereafter for its maintenance.

A more permanent channel would doubtless be one in the direction of the ebb flow across the outer end of Caucus Shoal, but to obtain this by dredging would cost, in round numbers, $357,000, and its self-maintenance without jetties to insure tidal scour and to protect the channel from the inflow of sand is doubtful.

There remains, then, the method of improvement by jetties, aided, if necessary, by dredging.

The further eastward advance of Caucus Shoal and southward advance of the Middle Ground Shoal should be arrested, and the ebb and flood flow should be united and trained across the bar in a favorable direction.

The location of the western jetty is fixed by the shore line, the present channel, and the direction of tidal flow across the bar. It now becomes necessary to so locate the eastern jetty as not only to arrest the westward travel of sand along the beach of Santa Rosa Island, but to obtain in the jetty channel the greatest tidal scour practicable without injury to the jetties themselves or to the present favorable tidal status of the bay.

From Mr. Turtle's report it appears that the present cross section of the gorge maintains a constant mean tidal range throughout the bay. During very high tides, however, the tidal range in the upper portion of the bay will doubtless be much less than at the entrance. In order to maintain the present tidal status it is assumed that the cross section at the entrance should not be diminished.

The area of the gorge cross section is given by Mr. Turtle in his report as 137,000 square feet, but from his map it appears to be ab[illegible]

Digitized by Google

116,000 square feet at low water, or 122,000 square feet at mean high water, which corresponds closely with that given by the United States Coast and Geodetic Survey chart, viz, 118,000 square feet at low water and 125,000 square feet at mean high water.

The shore arms of the two jetties, built on the lines shown to mean high water, will inclose a cross-sectional area of about 110,000 square feet. This will doubtless be increased by ebb and flood scour, the old path of the flood having been closed by the arm springing from Santa Rosa Island. It is therefore probable that at that point the section will soon increase without artificial means to the requisite area.

From the outer end of the Santa Rosa Island arm the eastern jetty extends southward, contracting the entrance at the seaward end of the jetties to 3,500 feet. About 1.5 miles from the gorge the high-water cross-sectional area between the jetties is only about 69,000 square feet. Although this will doubtless be much increased by scour it is not considered safe to even temporarily reduce the section to that extent. It is therefore proposed to keep the eastern jetty sufficiently low to gain in that manner the additional high-water area required. There being at that point an effective width of about 4,000 feet between the jetty and the Santa Rosa Island shore, it follows that the crest of the jetty should be kept about 15 feet below mean high water until the area between the jetties has been increased enough by scour to allow of a greater height. At the seaward end the high-water cross-sectional area between the jetties amounts to about 85,000 square feet. With the eastern jetty 15 feet below there results a sufficient cross-sectional area at that point to avoid injury to the tidal status of the bay. In order to maintain throughout the jetty channel cross-sectional areas approximately equal to that at the gorge, the eastern jetty may eventually, with increased scour between the jetties and accumulation of sand on its seaward side, be brought up to the mean height of the beginning of the ebb out-flow.

We have, as has been seen, during the time of effective ebb flow, a discharge of 236,000 cubic feet per second through a section of 122,000 square feet, rendering a mean velocity of nearly 2 feet per second, which will doubtless correspond to a bottom channel velocity at the time of maximum ebb current of somewhat more than 2 feet per second.

What amount of dredging, if any, may be required to obtain a channel 24 feet deep at mean low water will depend on the character of the material encountered. Should it be hard to set in motion it may become necessary to open a channel across the outer end of Caucus Shoal by dredging, but once open it is believed that the channel will be self-maintaining.

9. DESCRIPTION OF JETTIES AND ORDER OF CONSTRUCTION.

It is proposed to build the shore arm of the western jetty up to high water; from the shoulder to a point 5,000 feet from the shore end of the jetty the crest should be brought up to the mean height of the beginning of ebb outflow; for the next 4,300 feet the crest should be brought up to mean low water, from which point it will sink to the foundation course.

The shore arm of the eastern jetty should be built up to high water; the crest of the jetty will then sink within a distance of 1,200 feet to the level of the foundation course.

It is proposed to construct the jetties with a foundation course of brush mattresses 100 feet in width, and a superstructure of rubblestone capped with concrete.

Digitized by Google

From the foundation to within 3 feet of mean low water the stone may be from 50 to 250 pounds in weight, with some smaller stones for filling voids in the hearting if necessary. Between mean low water and 3 feet below, the jetties should be built of stone, none of which should weigh less than 250 pounds, with perhaps a hearting of smaller rubble, as before mentioned. For such portion of the jetties as rise above mean low water a capping of concrete, or of blocks of stone from 2 to 4 tons in weight, should be used. Concrete is proposed.

A crest width at mean low water of 10 feet is assumed as sufficient, and from the experience gained at points of greater exposure on the South Atlantic coast, it is assumed that the stone will stand at a slope of 1 on 2 down to 3 feet below mean low water and with a slope of 1 on 1.5 below that level.

The shore extension of the jetties to the storm high-water line may be built as proposed for the jetty proper, or of pile dikes filled with brush and stone. For a portion of the shore extension a simple sand catch may be sufficient.

The general order of construction recommended is, first, to construct the shore extension and shore arm of the western jetty; second, to construct the shore extension and shore arm of the eastern jetty, and at the same time complete the foundation course of the western jetty; third, to complete the western jetty; fourth, to complete the eastern jetty to such height as may be found necessary. It is desirable for the immediate relief of commerce and to assist the natural scour to do some dredging in the jetty channel, and this has been provided for in the estimate. Abrasion of the shore line in the vicinity of Fort McRee and at the entrance to the lagoon should be prevented, but as no work may be needed for that purpose estimates for it have not been submitted.

That advantage may be taken of experience gained in the work, wide discretion should be allowed the engineer in charge, especially as to the form of the jetty cross section and the order in which work is to be done.

10. ESTIMATES.

The following is the estimated cost of the improvement:

Western jetty:		
Shore extension, 100 feet, at $20 per linear foot	$2,000	
Brush mattresses, 123,000 square yards at $1 per square yard	123,000	
Ordinary rubble, 171,000 cubic yards at $3.50 per cubic yard	598,500	
Large rubble, 18,500 cubic yards at $6 per cubic yard	111,000	
Concrete, 2,500 cubic yards at $12 per cubic yard	30,000	
		$864,500
Eastern jetty:		
Shore extension, 150 feet at $20 per linear foot	3,000	
Brush mattresses, 120,000 square yards at $1 per square yard	120,000	
Ordinary rubble, 115,000 cubic yards at $3.50 per cubic yard	402,500	
Large rubble, 2,500 cubic yards at $6 per cubic yard	15,000	
Concrete, 750 cubic yards at $12 per cubic yard	9,000	
		549,500
500,000 cubic yards of dredging at 50 cents per cubic yard		250,000
Total		1,664,000
Engineering and contingencies, 10 per cent		166,400
Aggregate		1,830,400

The estimated cost of the improvement, which, in round numbers, is $1,830,000 supposes that money is regularly and adequately supplied. Without this the cost of the work will be largely increased and its success rendered doubtful.

Digitized by Google

Digitized by Google

Digitized by Google

Should it become necessary to raise the eastern jetty to the mean height of the beginning of ebb outflow the cost of the improvement will be increased.

11. APPENDICES.

The following appendices accompany this report:

1. Map showing location of jetties proposed by the Board.
2. *Photographs of relief map of Pensacola Harbor (3 copies).
3. †Report of W. D. Chipley on commerce of Pensacola.
4. Report of Capt. P. M. Price, Corps of Engineers, including
a. Report of Mr. J. E. Turtle, Assistant Engineer.
b. *Tracing, entrance to Pensacola Harbor.
c. *Tracing, entrance to Pensacola Harbor, showing comparative contours.
d. *Tracing, entrance to Pensacola Harbor, showing tidal velocities and directions.
e. *Diagrams of tidal velocities (10 sheets).
f. *Tabulated tidal velocity observations (3 sheets).

Respectfully submitted.

PHILIP M. PRICE,
Captain, Corps of Engineers.
W. M. BLACK,
Captain, Corps of Engineers.
O. M. CARTER,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 3, 1891.

Respectfully referred to Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, for remark.

By command of Brigadier-General Casey.

H. M. ADAMS,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, August 8, 1891.

Respectfully returned to the Chief of Engineers.

The estimated cost of obtaining 24 feet of water by dredging is $190,000, and its annual maintenance is estimated at $30,000.

The estimated cost of the proposed low jetties is $1,830,000, while the final cost will probably be considerably greater. At 3 per cent. the annual interest on $1,830,000 would be $54,900, much exceeding the estimated cost of maintenance of a dredged channel.

In view of these figures and of the success thus far obtained in the maintenance of the Sandy Hook Channel, I think that the improvement should be continued by dredging, until it is found that $50,000 a year will not maintain a channel after it is once completed.

C. B. COMSTOCK,
Col. of Engrs., Bvt. Brig. Gen., U. S. A.,
Division Engineer.

*Not printed. †Supplementary report printed.

Digitized by Google

SUPPLEMENTARY REPORT OF MR. W. D. CHIPLEY, CHAIRMAN OF COMMITTEE OF PENSACOLA CHAMBER OF COMMERCE.

PENSACOLA, FLA., *March 23, 1891.*

SIR: I beg to submit as supplementary to my argument of February 18 the following, bearing upon the value of Pensacola's exports and imports, coastwise and foreign. After a careful conference with the merchants I beg to say that a movement is now fairly started through which our harbor will export, in addition to the timber and cotton, gas and steam coal, iron from the furnaces of Alabama, iron pipe, railroad, bridge, and car material, house and ship-building material, including dressed and finished flooring, ceiling, and weather boarding. I will mention that one party has arranged for a large shipment of iron pipe from Birmingham via Pensacola to a port in the State of Washington, on the Pacific coast, saving $11 per ton after allowing for interest and insurance. In addition to this we are beginning to send cotton goods and western produce of every kind, and machinery, to the Americas south of us, which will be largely increased under the policy of reciprocity.

The imports at present consist of fruits principally, but to this will be added the hard woods of the Americas south of us, coffee, Bessemer iron ore from Cuban and Central American points, asphalt and all the products of those rich countries.

There is no doubt but what the deepening of our bar to 26 feet would reduce freights materially. Vessels of larger capacity can be operated at smaller expense proportionately and can in the same proportion accept lower rates of freight. A dozen merchants, to whom this matter has been referred, vary in their estimates from 8 to 20 per cent. reduction.

The present rates of freight on vessels of a tonnage of 400 to 800 tons register is £4 15*s.* per standard of 165 cubic feet of timber. Vessels of 900 to 1,300 tons, £4 5*s.* to £4 8*s.* For the same quantity, if there was water enough to admit of larger vessels, we could get freights at £4.

The other freights are too problematical to quote in this communication, some of them being prospective. I submit:

Value of exports from Pensacola to foreign countries from February 1, 1890, to February 1, 1891.

Lumber	$3,067,985
Coal	73,862
Assorted merchandise	33,193
Cotton	1,101,641
Rosin	256
Total	4,297,037

Value of exports coastwise from Pensacola from February 15, 1890, to February 15, 1891.

Pig iron	$10,500
Coal	20,232
Lumber	258,332
Assorted merchandise	227
Stone	1,700
Shingles	879
Total	291,870

Value of imports from domestic ports, at Pensacola, for the year ending February 15, 1891.

Assorted merchandise	$3,345
Coal	2,406
Ice	2,500
Fertilizers	200,750
Household goods	2,000
Total	211,001

Digitized by Google

Value of imports from foreign countries at the port of Pensacola for 12 months, from February 15, 1890, to February 15, 1891.

Assorted merchandise	$3,124.83
Fruit	14,210.94
Salt	8,318.62
Portland cement	11,249.07
Liquors	167.47
Fertilizers	35,975.84
Brimstone	23,206.03
Machinery	12,839.00
Total	109,091.80

The projected railroads seeking outlet at Pensacola are numerous, but I will only mention three, as they have made a start toward the construction of lines.

The Mobile and Girard Division of the Central Railroad of Georgia at its annual meeting a few months ago voted authority to issue bonds for the extension of its line from Troy via Andalusia to Pensacola. General Alexander, the president, expressed his views as to its importance, and there can be no doubt about the ultimate construction of this road, which already has 400 men at work.

A second road is via Williams Station, on the Mobile and Montgomery Division of the Louisville and Nashville, and Suggsville, on the Mobile Division of the East Tennessee, Virginia and Georgia, to Meridian.

This company has made its surveys, has purchased valuable terminal facilities at Pensacola, and its projectors say that they will soon commence the construction of same. Some work has already been done.

A third road is now being surveyed which is designed to go towards the northwest, and the line has already been located near the center of Eutaw County, Ala.

Yours, truly,

W. D. CHIPLEY,
Chairman.

Capt. O. M. CARTER,
Corps of Engineers, U. S. A.
Secretary of Board of Engineers upon improvement of Pensacola Harbor, Florida.

P 8.

IMPROVEMENT OF ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA.

PLAN OF IMPROVEMENT.

The Escambia and Conecuh Rivers are really one river, that portion of the river from its headwaters, in southeastern Alabama, to the Florida and Alabama State line being called the Conecuh River and the portion in Florida being called the Escambia River.

Under an act of Congress approved June 18, 1878, an examination and partial survey was made in 1878 and 1879 from the mouth of the river, at the head of Pensacola Bay, to Indian Creek, in Alabama, an estimated distance of 293 miles.

The plan of improvement adopted pursuant to this examination provides for the improvement of the river by the removal of logs and snags from the channel and overhanging trees from the banks, by excavating rock shoals, deepening sand bars by works of contraction and shore protection, and by dredging through a bar at the mouth of the river.

The object of the improvement is to facilitate the movement of saw logs and timber rafts down the river and to afford at the same time a suitable channel for steamboat navigation. The improvement must be maintained by the removal of fresh obstructions each year. The banks

Digitized by Google

are heavily timbered and the accumulation will be large. It is estimated that an annual appropriation of about $5,000 will be required for the maintenance of the improvement.

APPROPRIATIONS.

June 14, 1880	$8,000
March 3, 1881	5,000
August 2, 1882	12,000
July 5, 1884	15,000
August 5, 1886	12,000
August 11, 1888	10,000
September 19, 1890	7,500
Total	69,500

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $5,791.66. With this amount it has not been practicable to maintain a suitable plant for expeditious work. One log-boat has been worn out in service upon this improvement and another transferred to it from the Cahaba River, which is moderately efficient. It should be provided with a stern wheel in order to be used economically.

Slow but steady progress has been made in the removal of obstructions, and navigation has been greatly benefited.

From its mouth to Thompson Cut-off, a distance of 133 miles, the river is in a fairly navigable condition for all stages higher than 2½ feet above low water, and the bar at the mouth of the river has been dredged to admit the passage of tugboats not drawing over 5 feet of water.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer J. E. Turtle, in local charge of the improvement, reports as follows:

At the beginning of the fiscal year the snag boat was on the ways in Pensacola, Fla., for the purpose of repairs, such as replacing partially decayed gunwales, plank, both bottom and deck, and recalking. These repairs were completed early in July, and the boat was then towed to Molino, Fla., where, owing to lack of funds, she was placed in charge of a watchman. Owing to the late passage of the river and harbor bill it was concluded not to resume operations until the low-water season of 1891. Accordingly the boat was not put in commission until May 18, 1891, when she began working upstream from Molino.

That portion of the Escambia River lying between the mouth and Brewton, Ala., will never, in my judgment, be used by boats, but will be confined to the rafting of logs and timber. The removal of obstructions, therefore, from this portion will have this object in view.

It is proposed, with the available funds during the fiscal year ending June 30, 1892, to continue the removal of obstructions and to make a survey of the dredged channel at the mouth.

Two steamboats have tried to start a trade upon this river, but have not met with success; and as a commercial stream, aside from timber trade, it is my opinion that it never will be a success. Much more than 50 per cent. of Pensacola's timber trade comes out of these rivers, and consequently it will always be an important stream; but this class of trade will not call for the improvement of bars or shoals, closing cut-offs, etc.

Several lumber merchants have spoken to me about dredging a channel from the bay into this river deep enough to admit any of the tugs. Such a channel through the bar would allow tugs to go to Ferry Pass for the timber rafts, which would do away with bringing the rafts out of the river and anchoring them to the timber-stand. This operation results frequently in the loss of timber, as many rafts are tied to these stands in good weather, but before they can be taken away are lost, or partially so, by storms. A channel 8 feet at mean low water will accomplish this, and, as this is a timber stream, seems to be an important feature of its improvement.

Digitized by Google

Such a dredged channel can be made more permanent by closing some of the lower bayous, which, owing to the cheapness of brush and piles in this locality, would not be expensive.

It is also advisable to alter the snag boat now on this river by putting in machinery and wheel. For this an estimate of $3,000 is recommended, and for the improvement of the lower river, above suggested, $12,000, or $15,000 above that amount required for snagging operations, or a total of $23,000. This should not be reduced.

RECOMMENDATIONS AND ESTIMATES.

As stated by the assistant engineer in the above-quoted report, it does not seem probable that these rivers will be much used for the present, at least by steamers for ordinary commerciel purposes; but they flow through the most extensive timber regions of south Alabama and Florida, and millions of feet of lumber are rafted on them annually.

In order that this business may be carried on safely and profitably it is necessary to remove the annual accumulation of logs and snags from the river. The bar at the mouth of the river should also be dredged to a depth of 8 feet at mean low water, in order that tugs may be able to ascend the river to Ferry Pass for the purpose of towing out the rafts, which are taken to Pensacola to be loaded on ships for export.

For efficient work on the river the log boat now belonging to the improvement should be provided with her own motive power, at an estimated cost of $3,000.

It is estimated that the cost of dredging an 8-foot channel through the bar at the mouth of the river will be $12,000.

The annual cost of running a snag boat is estimated at $5,000, or $10,000 for 2 years.

The amount that can be profitably expended on the improvement of these rivers is therefore estimated at $25,000

Money statement.

July 1, 1890, balance unexpended	$1,914.38
Amount appropriated by act approved September 19, 1890	7,500.00
	9,414.38
June 30, 1891, amount expended during fiscal year	2,361.83
July 1, 1891, balance unexpended	7,052.55
July 1, 1891, outstanding liabilities	653.84
July 1, 1891, balance available	6,398.71
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	25,000.00

COMMERCIAL STATISTICS FOR ESCAMBIA AND CONECUH RIVERS, FLORIDA AND ALABAMA, 1891.

During the early part of the year the stern-wheel steamboat *Mary Alice* made one trip from Pensacola, Fla., to Andalusia, Ala., and one trip between Brewton, Ala., and Andalusia, Ala., carrying 146 tons of freight. The *Mary Alice* was then transferred to the Choctawhatchee River.

A small stern-wheel boat, the *Eliza Ann*, made a few local trips last winter in the vicinity of Harold's Mill. The owners of this boat, Messrs. John S. Stanton & Son, of Flomaton, Ala., report as follows:

"We never started our boat until the season was over. The main work is fertilizer and cotton, and there is a splendid run from Harold's Mill to Andalusia, about 45 miles, by land, and no conveyance, except private. That part of the river could be made navigable for a light draft boat with very little work done."

Digitized by Google

While the steamboat commerce of this river is insignificant, the lumber business is very large, and the improvement of the river to permit its safe use is of great importance to the lumber interests.

Freight carried.

	Tons.
Cotton, 225 bales	56
Fertilizers, 550 sacks	55
Timber	944,232
Grain, 700 sacks	55
Salt, 120 sacks	12
Shingles, 4,000 pieces	2
Brick, 5,000, number	12
Miscellaneous	5
Total	944,429

Estimated value of above freight, in round numbers, $1,755,896.

P 9.

IMPROVEMENT OF ALABAMA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

An examination and partial survey of this river made in 1875 resulted in the adoption of a project for the improvement of the river, which provides for obtaining a channel 200 feet in width and 4 feet in depth at low-water from Wetumpka, Ala., to its mouth, 44 miles above Mobile, Ala., a distance of 293 miles, by the removal of snags, logs, etc., from the channel and overhanging trees from the banks, removing rock reefs, and gravel bars by blasting and dredging, and sand bars by works of contraction and shore protection.

The river has generally a movable bottom and caving banks, with numerous shoals and bars, with an average slope of about 4 inches per mile. The normal width of the upper portion of the river is from 500 to 600 feet, and of the lower portion from 700 to 800 feet; and in the portions of the river having these widths the low-water depths in the channel are from 8 to 15 feet. Where these widths have been increased by the erosion of the banks, shoals, bars, and reefs are found. The report of 1876 specifies 116 of these requiring improvement. An annual expenditure will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works constructed and for the extension of the improvement.

APPROPRIATIONS.

June 18, 1878	$25,000	August 5, 1886	$15,000
March 3, 1879	30,000	August 11, 1888	20,000
June 14, 1880	25,000	September 19, 1890	20,000
March 3, 1881	20,000		
August 2, 1882	20,000	Total	185,000
July 5, 1884	10,000		

OPERATIONS TO JUNE 30, 1890.

Under the approved project work was begun in 1878 and continued during the low-water season of each year until 1883. During this period of 5 years the average annual appropriations were $22,000, and with this

Digitized by Google

amount considerable snagging work was done, and dams, or jetties built of brush and stone, rock, or pile work and stone, were constructed at eight of the most troublesome bars, viz: The Cut-off, Haines Island, Hobbs Island, Yellow Jacket, Gardner Island, Hadnot, Cox, and Three Chutes.

During the past 8 years the average annual appropriations have been but $9,375, which have not sufficed for the proper maintenance of the improvement, and nearly all the jetties and dams are much in need of repair. A great deal of useful work has, however, been accomplished by the removal of logs and snags from the channel and by cutting and trimming overhanging trees. Many of the shoal places in the river are caused by the accummulation of sand and gravel about sunken logs and snags, and a number of the troublesome bars have been permanently improved simply by the removal of these obstructions, without resorting to jetties and wing dams.

Before the improvements were begun in 1878 the river was so full of sunken logs and snags and so obstructed by bars and shoals, on many of which the low-water depth was only 2½ to 3½ feet, that navigation was both difficult and dangerous, and many boats were destroyed by striking snags. At low-water stages boats could only run by daylight, and long detentions at the bars and shoals were frequent, 2 or 3 weeks being sometimes occupied in the trip between Mobile and Montgomery.

No opportunity has been had for noting the results of the unusually long-continued high-water season during the past winter and spring; but it is believed that a depth of 4 feet at low water will be found on all the bars, although the channel will have on but few of them the required width of 200 feet.

Considerable difficulty is now experienced at low stages of water at the following bars, viz: The Cut-off, the Wrecks, Haines Island, Stein Island, Gardner Island, and Hadnot Bar.

It is hoped that with the funds now available some improvement can be made at one or more of these bars during the summer of 1891, after all absolutely necessary snagging operations have been completed.

Boats now run by night as well as by day, at all stages of water, carry greater loads, and regularly make the round trip from Montgomery to Mobile and return in one week.

WORK DONE DURING PAST FISCAL YEAR.

Assistant Engineer C. B. Percy, in local charge of the improvement, reports as follows:

The repairs to the steam snag boat *W. J. Twining* were completed August 1, but as the amount of funds on hand available for this improvement was small, active operations were not resumed until September 1, when there was a reasonable certainty of the passage of the river and harbor bill then before Congress.

In accordance with orders received September 1 the crew was organized, the boat put in working condition, supplies taken on board, and on September 5 was started down the river with orders to proceed through to the mouth, a distance of 243 miles, removing on the way down all logs or snags immediately in the channel usually run and that were dangerous to navigation.

This was done, and the mouth was reached September 12, when the steamer was ordered to turn back and to work upstream and carefully clean the river as she came of all sunken logs, snags or fallen-in timber, to fell and pull back all overhanging timber in the way of passing steamboats, and to clear the banks of undergrowth or willows at the chutes where the channels were narrow and close under bank at low water. The river was thus cleaned from the mouth to Canton Upper Bar, a distance of 103¼ miles, by October 13. Heavy rains now set in and, the river rising rapidly, the snag boat was ordered to Bridgeport, 3 miles above, for a safe harbor, and remained there until October 20, when she was started for Montgomery in obedience to orders to return to that city and lay up. This was done on account of the con-

Digitized by Google

tinued high water, and, also, as the river was comparatively free of all dangerous obstructions, such as sunken logs, snags, and overhanging timber, this kind of work was suspended in order that as large a portion as possible of the appropriation made September 19, 1890, might be expended in repairing the jetties and dams and constructing new ones where most needed. The boat reached Montgomery October 22; after all tackle was taken down and stowed away, all machinery taken apart and white-leaded, and pipes and boilers drained, the crew was discharged and work suspended for the winter season on October 31.

High water continuing throughout the entire spring of 1891, active operations on the Alabama River were not resumed until May 20, when the crew were reorganized, and work commenced on that portion between Montgomery and the junction of the Coosa and Tallapoosa Rivers, where very little work has heretofore been done and where work was necessary to be done on account of transporting freight and material to be used in the construction of the lock on the Coosa River at Wetumpka this fall.

In addition to the snagging work, a distance of 115 lineal feet at the upper end of the broken jetty just below Haines Island was partially filled with snags removed from the chutes at the bar below and the island above; also the gap of 50 feet in the dam behind Hobbs Island was partially closed with large logs and fallen-in timber removed from the channel at that island.

The latter work has resulted in increasing the depth and straightening the channel above.

The total distance thoroughly worked over during the fall season was 103¼ miles; and for 140 miles the logs and snags dangerous to navigation were removed.

RECOMMENDATIONS AND ESTIMATES.

The act of September 19, 1890, required an examination of the Alabama River to ascertain the cost of securing a 6-foot channel at low water from the mouth to Wetumpka.

My report on this examination was submitted on December 10, 1890, and is published as House Ex. Doc. No. 140, Fifty-first Congress, second session.*

For the reasons that the present large and growing commerce of the Alabama River would be greatly benefited by having a 6-foot channel, and that this river, with its tributaries, forms a natural route for the transportation to the Gulf of Mexico of the coal and iron products of a vast territory, and that a 6-foot channel will be required for the profitable development of this traffic, I reported that in my opinion the river was worthy of improvement as proposed and estimated the cost of securing a 6-foot channel at $386,251 and the annual cost of maintaining the same at $10,000.

My recommendations were approved by the Division Engineer, Col. C. B. Comstock, Corps of Engineers, and by the Chief of Engineers, U. S. Army.

Should the recommendations for securing a 6-foot channel in the Alabama River be approved by Congress, it is estimated that $100,000 can be profitably expended during the fiscal year ending June 30, 1893.

Money statement.

July 1, 1891, balance unexpended	$4,597.95
Amount appropriated by act approved September 19, 1890	20,000.00
	24,597.95
June 30, 1891, amount expended during fiscal year	7,042.17
July 1, 1891, balance unexpended	17,555.78
July 1, 1891, outstanding liabilities	1,154.05
July 1, 1891, balance available	16,401.73
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	100,000.00

* See also Appendix P 15.

Digitized by Google

COMMERCIAL STATISTICS FOR ALABAMA RIVER, ALABAMA.

The following statement of the business done by the steamboats named below during the fiscal year ending June 30, 1891, has been compiled from statements furnished by Mr. James F. Quill, agent of the Alabama River line of steamers, and by Capt. W. H. Moore, master of the *Tinsie Moore*. These boats run from Mobile, Ala., to Montgomery, Ala., and return, stopping at all intermediate landings where business is offered.

Stern wheel steamboats.	Registered tonnage.	Draft of water.		Number of round trips between Mobile and Montgomery.	Number of passengers.
		Light.	Loaded.		
		Inches.	*Feet.*		
Nettie Quill	226.93	28	6	52	10,647
Tinsie Moore	160.23	24	5½	41	5,188
Anderson				25	9,361
Armstrong	197.50	19	5	27	

Freight carried.

	Tons.		Tons.
Cotton, 52,349 bales	13,087	Staves, 121,000 pieces	1,785
Cotton seed, 155,224 sacks	7,761	Provisions, 185,845 packages	6,228
Fertilizers, 108,644 sacks	6,808	Grain, 113,786 sacks	8,586
Hides and skins, 257 packages	50	Miscellaneous freight, 274,845 packages	10,962
Live stock, 2,630 head	1,300		
Lumber, 367,520 feet B. M.	1,008	Total	57,575

Estimated value of above freight, in round numbers, $8,175,650.

P 10.

IMPROVEMENT OF TALLAPOOSA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 14, 1880, an examination and partial survey of this river was made, which resulted in the adoption of a project for improvement designed to obtain a navigable channal from its junction with the Coosa River, where the two rivers form the Alabama, to the foot of Tallassee Reefs 2 miles below Tallassee, the head of navigation, a distance of 48 miles; the channel in open river to be 200 feet in width, with a least depth of 3 feet at low water, and in rock cuts to be 60 feet wide and 3 feet deep at low water. The project is to be accomplished by the removal of snags, logs, etc., from the channel, the cutting of overhanging timber from the banks, by rock and gravel excavation through reefs, and by deepening sand bars by works of contraction and shore protection. The river generally presents long reaches of fine open navigable water, with a width of 200 to 300 feet and depth of 6 to 12 feet. When this width is exceeded to any extent sand bars and gravel or rock reefs are found. The banks generally of the first 30 miles below Tallassee are firm and stable, but those of the lower river are of soft unstable material, which yields readily to the eroding action of the river when unprotected by a growth of brush or cane.

The river runs through a continuous succession of rich bottom land,

Digitized by Google

largely cultivated, and adjacent uplands of good arable soil, with the more hilly portions covered with forests of fine pine timber. The falls at Tallassee furnish magnificent water-power, which is now partly utilized by extensive cotton mills. The river is not susceptible of permanent improvement, and will require an annual appropriation, estimated at $5,000, for the removal of obstructions constantly accumulating in the channel, and for the repair of contraction works in order to maintain it in the condition contemplated by the plan of improvement.

APPROPRIATIONS.

August 2, 1882	$15,000	September 19, 1890	$4,000
July 5, 1884	10,000		
August 5, 1886	7,500	Total	44,000
August 11, 1888	7,500		

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has thus been $4,888.89, and with this amount it has been practicable, besides completing and equipping a suitable snag boat, to keep only one small working party upon the improvement during low-water seasons. The operations have been confined to the removal of logs and snags from the channel, cutting down and removing the most dangerous overhanging timber, building 320 feet of temporary jetty, reworking each year the part passed over during the previous season, and extending the improvement as far upstream as the funds available would permit.

At the close of the season's work, in November, 1889, there was a fairly navigable channel for light-draft steamers from the mouth of the river to Cowles Ferry, a distance of 43 miles. The shoals, which owed their existence to logs and snags, have disappeared on the removal of the same. During the latter part of the fiscal year ending June 30, 1890, the plant was overhauled and repaired as far as the funds available would permit. Very considerable and much-needed improvement was made both in machinery and quarters of the snag boat.

WORK DONE DURING THE PAST FISCAL YEAR.

Owing to the fact that the funds for this improvement were very nearly exhausted at the close of the fiscal year ending June 30, 1890, and that the high-water season set in soon after the funds appropriated by the act of September 19, 1890, became available, and that the high water continued until late in the spring, no work has been done beyond the preservation and caring for the property pertaining to this improvement.

RECOMMENDATIONS AND ESTIMATES.

At extreme low-water stages of the river there are three shoals, or rock reefs, that now form the most serious obstructions to navigation. They are known as "Sunken," "Zimmermans," and "Goodwins" reefs, 35, 38, and 39 miles, respectively, above the mouth. They are composed of scattered bowlders and solid ledges of rock, and at low water the depth over them varies from 1 to 2 feet. A channel can be readily cut through them by blasting, and it is contemplated to commence this work during the present working season, and continue it as long as the funds available will permit.

It is anticipated that with a favorable working season channels 60

Digitized by Google

feet wide and 3 feet deep through these reefs can be nearly, if not quite, completed by December, 1891.

In addition to this rock excavation, that portion of the river between Cowles Ferry and the foot of Tallassee Falls, a length of 5 miles, is to be cleared of logs and snags and overhanging timber. The cost of this work is estimated at $1,000 per mile, or a total of $5,000.

The original estimate of the cost of the improvement was $40,125. This estimate contemplated the making of sufficient appropriations to complete the improvement in two or three seasons, but work so far has been extended over a period of 9 years, with insufficient appropriations, and the greater part of the money available has in consequence been expended in removing the annual accumulation of logs and snags. An estimate of the amount required for the completion of the existing project can not be submitted without further detailed surveys, for which funds have not been available.

The amount that can be profitably expended during the fiscal year ending June 30, 1893, is $15,000.

Assistant Engineer C. B. Percy is in local charge of this improvement.

Money statement.

July 1, 1890, balance unexpended	$351.42
Amount appropriated by act approved September 19, 1890	4,000.00
	4,351.42
June 30, 1891, amount expended during fiscal year	832.70
July 1, 1891, balance unexpended	3,518.72
July 1, 1891, outstanding liabilities	44.32
July 1, 1891, balance available	3,474.40
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	15,000.00

COMMERCIAL STATISTICS.

There has been in recent years no attempt to regularly ply this river, and only one or two trips made by steamboats, consequently the business on the river is confined to rafting logs, hewn pine and oak timber, of which no record has been kept. The total commercial value of agricultural products, actual and estimated, of the section tributary to the proposed improvement is $2,100,000. Responsible parties in Montgomery propose to put a steamer on this river to run between Montgomery and the foot of the Tallassee Falls as soon as a depth of 3 feet at low water, is obtained. Large cotton factories are established at Tallassee, the head of the present improvement.

The census of 1880 gives for the counties bordering on the river within the limits of the proposed improvement a total assessed valuation of real and personal property amounting to $13,528,123, and a total taxation of $258,052.

P 11.

IMPROVEMENT OF COOSA RIVER, GEORGIA AND ALABAMA.

PLAN OF IMPROVEMENT.

In 1870 an instrumental survey of this river was made from Wetumpka, Ala., to the East Tennessee, Virginia and Georgia Railroad Bridge, a distance of 68 miles, and an examination from this point to

Digitized by Google

Greensport, Ala., a distance of 74 miles. In 1872 an instrumental survey was made from the said bridge to Greensport. In 1874 an examination was made between Rome, Ga., and Gadsden, Ala., an estimated distance of 133 miles. In 1878 a detailed resurvey was made of Whistenant and Ten Island shoals, below Greensport.

Pursuant to these examinations and surveys a plan of improvement was adopted which provided for the removal of the lesser rock shoals and sand and gravel bars, by excavation and by works of contraction, so as to give a minimum depth of 3 feet at low water in the channel, and the construction of locks and dams to overcome the more serious obstructions. The approved project was limited to the section of river between Rome, Ga., and the East Tennessee, Virginia and Georgia Railroad Bridge, an estimated distance of 236 miles.

In 1889 an instrumental survey was made from Lock No. 4, 26 miles below Greensport, to Wetumpka, Ala. The report on this survey was printed in the Annual Report of the Chief of Engineers for 1890, page 1665.

The act of September 19, 1890, contained the following provision:

Improving the Coosa River in Georgia and Alabama between Rome, in Georgia, and the East Tennessee, Virginia and Georgia Railroad Bridge, in Alabama: Continuing improvement under approved existing project, $150,000. Also for improving said river between Wetumpka, in Alabama, and said East Tennessee, Virginia and Georgia Railroad Bridge, work to be commenced at Wetumpka end, $150,000, of which so much as may be necessary is authorized to be expended in acquiring by purchase, or condemnation under the laws of Alabama, the lands needed in making such improvement, as the same become necessary, such improvement to be made in harmony with the existing approved project for the improvement of the Coosa River between Rome and said bridge; locks to be 40 feet wide and 210 feet between miter sills.

The river was originally much obstructed by rock shoals and sand bars between Rome, Ga., and Greensport, Ala., and below Greensport it was not navigable at all, on account of the many shoals and rapids formed by ledges of rock crossing the river bottom at points where the width of the river was greater than the normal. The normal width of the river at low water is from 500 to 800 feet. From Rome, Ga., to Greensport, Ala., an estimated distance of 162 miles, the river has an average slope of about 5 inches per mile, with banks which are firm and not easily eroded. From Greensport down to Wetumpka, Ala., an estimated distance of 142 miles, the profile of the natural river at low water exhibits a succession of deep pools, varying in length from one-half to 8 miles, separated by shoals formed of ledges of solid rock or loose stones and detached bowlders, which frequently rise above the surface. The shoals extend along the river for distances varying from a few feet to 12 miles, and have depths of water varying from a few inches to several feet. Velocity observations at Wetumpka showed a low-water discharge of 5,796 cubic feet, about the same as that reported for the Mississippi River at St. Paul. The abundance of water, the stability of the banks and bottom of the river, and the rock foundations for locks and dams presented in all cases, make the lower portion of the river peculiarly susceptible of permanent improvement by a system of slack-water navigation.

By means of the Upper Coosa, the Oostenaula, and Coosawattee rivers there is now a stretch of 293 miles of navigable river above Lock No. 4; and by means of the Coosa and Alabama rivers a stretch of 367 miles of easily navigable river below Wetumpka. The improvement of the 116 miles of river between Lock No. 4 and Wetumpka will therefore afford a continuous route of water transportation, 776 miles in

Digitized by Google

length, from northwestern Georgia, through the mineral region of north Alabama to the Gulf of Mexico at Mobile, Ala.

RECOMMENDATIONS.

The original project provided for locks 40 feet wide and 210 feet between miter sills, giving an available length of 175 feet; and locks Nos. 1, 2, and 3, have been built with these dimensions. The actual construction of Lock No. 4 has not yet been begun. The most important coal fields along the Coosa River are in the vicinity of Broken Arrow, between locks Nos. 3 and 4. The main coal traffic will therefore be upstream through locks Nos. 1, 2, and 3, and downstream through Lock No. 4, and those below it. At locks Nos. 1, 2, and 3, all tows will have to be broken up, and each towboat and barge locked through separately. Between the Broken Arrow coal fields and Wetumpka, it is estimated that 28 locks will be required. Should these locks be made of the size directed by the law of September 19, 1890, it will be necessary to break up every tow at each of the 28 locks, and pass each towboat and barge through separately. This operation will involve so great a loss of time and so much additional expense that it is doubtful if the coal and iron ore traffic, the development of which is the main object of the improvement, could be profitably carried on.

On no other river, whose improvement by locks and dams has been undertaken by the Government of late years, has a size of lock less than 52 feet wide by 322 feet between miter sills, giving an available length of 280 feet, been adopted. The reports of Boards of Engineers on all recent improvements state emphatically that this is the smallest size of lock suited to a profitable coal and iron ore traffic. The locks being built on the Black Warrior and Cumberland rivers are of this size. The new locks on the Great Kanawha River are larger. It is therefore urgently recommended that the present law defining the size of the locks may be so amended in the next appropriation bill as to permit the new locks on the Coosa River to be built of the standard size, namely, 52 feet wide by 322 feet between miter sills. The available length of such a lock is 280 feet. This will permit the passage through the locks, at one time, of one towboat 150 feet in length by 25 feet wide, and three standard coal barges each 130 feet long and 25 feet wide.

This suggested change in the law requires no sacrifice of work already done. No actual construction work on the locks proper will be done with the present appropriation, either at Lock No. 4, on the Upper Coosa, or at Lock No. 31, at Wetumpka.

1. BETWEEN ROME, GEORGIA, AND THE EAST TENNESSEE, VIRGINIA, AND GEORGIA RAILROAD BRIDGE.

APPROPRIATIONS.

August 14, 1876	$30,000	July 5, 1884	50,000
June 18, 1878	75,000	August 5, 1886	45,000
March 3, 1879	45,000	August 11, 1888	60,000
June 14, 1880	75,000	September 19, 1890	150,000
March 3, 1881	60,000		
August 2, 1882	83,700	Total	673,700

OPERATIONS TO JUNE 30, 1890.

The average annual appropriation has been $44,913.33. The principal rock obstructions have been removed from the channel between

Digitized by Google

Rome, Ga., and Gadsden, Ala., and a number of shoals have been improved by wing dams, so that navigation has been greatly benefited, and a line of steamboats makes regular trips between these points, and extends these trips to Greensport, Ala., when business demands it.

Below Greensport, at distances respectively of .68, 3.86, and 5.24 miles, three permanent masonry locks, each 40 feet wide by 210 feet between miter sills, with their accessory dams, were sufficiently completed to be opened to navigation in the spring of 1890. Steamboats now extend their trips to landings a few miles below Lock No. 3.

On the completion of the dam at Lock No. 4, which it is expected to accomplish during the present summer, boats can reach this point, which is about 3 miles above the bridge of the Georgia Pacific Railroad at Riverside, Ala.

WORK DONE DURING PAST FISCAL YEAR.

Lieut. Charles L. Potter, Corps of Engineers, U. S. A., was in local charge of this work from September, 1890, until relieved by Lieut. Wm. E. Craighill, Corps of Engineers, U. S. A., on June 8, 1891. Lieutenant Craighill submits the following report:

All the work was suspended during the year until the latter part of September, when active operations were again resumed, and have been carried on as follows:

Lock No. 1.—Two levees, each with a top width of 8 feet and elevation above the lock coping of 10 feet, and side and end slopes of 1 on 2 have been built and heavily paved around the ends. The yard has been paved the entire length of the lock, and for a distance of 80 feet back of the lock wall. A gutter has been built behind the lock wall extending from the head to the foot of the lock.

Two timber guide piers filled with broken stone have been built, one at the head and one at the foot of the lock. A lock keeper's dwelling has been built. The stone for finishing the coping, a part of that for strengthening the dam, all used in building the pillars under the lock keeper's dwelling at Lock No. 3, and a part of that used in the pillars under the lock keeper's dwelling at Lock No. 2, was quarried near this lock.

All improvements contemplated have been made.

Lock No. 2.—A timber guide pier filled with broken stone has been built at the foot of the lock. The yard has been graded and a gutter built behind the lock wall extending the entire length of the lock. All stone used here and at Lock No. 3, except that mentioned under the head of lock No. 1, has been quarried here. A lock keeper's dwelling has been built.

All improvements heretofore proposed at this lock have been made, except the building of a guide crib at the head of the lock.

Lock No. 3.—A timber guide pier at the head of the lock has been completed. The yard has been graded and paved. A levee extending the entire length of the lock has been built, and paved where subject to scour. A timber guide pier to be placed at the foot of the lock has been framed. A lock keeper's dwelling has been built. The work of strengthening the dam and north abutment is well advanced towards completion.

Lock No. 4.—All work at this lock had been suspended since the fall of 1888, except that of making surveys and taking current velocity observations. Active operations were again resumed in April, 1891, and have been vigorously prosecuted since then. The cross section of the dam has been materially enlarged over the one originally designed, necessitating the purchase of much additional lumber. A tramroad 1.9 miles long has been graded from the site of the lock to the quarry, and the ties and rails laid. A quarry has been opened and a part of the stone required for the dam and abutment has been quarried. A Lidgerwood hoisting and conveying apparatus for filling the dam and conveying stone to the western abutment of the dam is being erected. The work of building the western abutment, although some trouble has been experienced with the foundation, has made satisfactory progress. The lock keeper's dwelling is nearing completion. That portion of the cofferdam which has to be built before the main dam has been partly completed.

Channel work.—After the opening of Lock No. 3 to navigation a steamboat passed through Lonnergan Reefs and returned, but found the cross current so strong that all attempts to pass below these reefs have been abandoned. Last November, during very low water, these reefs were carefully resurveyed, and from this a relocation of

Digitized by Google

the channel has been made with its axis parallel to the direction of the current. The channel work has been concentrated at this point, and every effort will be directed to opening the channel to navigation during the present working season. The opening of the channel through these reefs will open up 8 miles more of the river to navigation.

Miscellaneous.—Five new barges have been built of the following dimensions: Three 3 feet 5 inches by 20 feet by 75 feet and two 2 feet 4 inches by 14 feet by 31 feet. The quarter boat, derrick boat, and one barge have been repaired and recalked. Repairs to buildings, tools, and machinery have been made as needed. A valuable working plant has been purchased. The work of improvement was greatly retarded by high water during the months of January, February, and March.

The work proposed for the fiscal year ending June 30, 1892, is as follows:

Lock No. 3.—It is proposed to complete all work here, including the rock-fill dam at the foot of Wood Island.

Lock No. 4.—At this lock it is proposed to complete the permanent dam, cofferdam, western abutment of the dam, the levee from the western abutment to the adjacent hillside, and the right of way from the Government reservation to the county road.

Channel work.—It is proposed to finish the channel through Lonnergan Reefs and all channel work between Locks Nos. 3 and 4, if practicable.

ESTIMATES.

The amount estimated as required for the completion of the existing project between Rome, Ga., and the East Tennessee, Virginia and Georgia Railroad Bridge, as given in the Annual Report for 1890, was based on the cost of locks 52 feet wide by 322 feet between miter sills, and on the estimated cost of dams, abutments, and levees recommended in my report of December 30, 1889. Since that time, on the recommendation of the Division Engineer, larger and more expensive designs for the dam, abutment, and levee, and more extensive bank protection have been adopted, and it is necessary to modify the estimates accordingly.

The estimated cost of a masonry lock 52 feet wide by 322 feet between miter sills, having a lift of 11 feet, which is the average lift of all the locks to be built on the Coosa River, is in round numbers $170,000; and of a similar lock 40 feet wide by 210 feet between miter sills, $130,000.

It is expected with the amount now available to complete during the present year the construction of the dam, abutment, and levee, and the upper part of the cofferdam at Lock No. 4.

The subjoined estimate of cost of completing the existing project provides for completing the construction of Lock No. 4, and for the construction of the four locks and dams, and for the intermediate channel work between that point and the East Tennessee, Virginia and Georgia Railroad Bridge, and is based on the estimated cost of locks 40 feet wide by 210 feet between miter sills, and on the estimated cost of the recently approved designs for the dam, abutment, and levee at Lock No. 4.

Money statement.

July 1, 1890, balance unexpended	$4,028.69
Amount appropriated by act approved September 19, 1890	150,000.00
	154,028.69
June 30, 1891, amount expended during fiscal year	63,713.61
July 1, 1891, balance unexpended	90,315.08
July 1, 1891, outstanding liabilities	22,294.11
July 1, 1891, balance available	68,020.97
Amount (estimated) required for completion of existing project	1,090,133.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Digitized by Google

2. BETWEEN WETUMPKA AND THE EAST TENNESSEE, VIRGINIA AND GEORGIA RAILROAD BRIDGE.

APPROPRIATIONS.

September 19, 1890 ..... $150,000

WORK DONE DURING THE PAST FISCAL YEAR.

Assistant Engineer Charles Firth, in local charge of this improvement, reports as follows:

As soon as the funds appropriated by the river and harbor bill of September 19, 1890, became available, a party was organized and proceeded to Wetumpka, in accordance with the project approved by the Chief of Engineers, October 1, 1890, "to make a detailed survey of the river and its banks for a distance of about 5 miles above that point, the first three locks having been approximately located within this distance."

A suitable building was rented for use as office and quarters, and the party took possession on November 4 and immediately proceeded to commence the work.

Pending the arrival of the surveying instruments, the first 4 weeks were spent in putting into thorough repair all necessary tools, making and graduating stadia, leveling, sounding, and ranging rods; making and fixing gauge boards; building a suitable skiff, another being bought at Mobile. The ground to be covered by the survey at the site of Lock No. 31 was examined and a system of triangulation and contouring decided upon.

Owing to the irregularity in the rise and fall of the river in the immediate neighborhood of the site, caused by the backing up from the Tallapoosa River, which joins the Coosa about 10 miles below, it was considered inadvisable to erect a water gauge at that point, as the records would be of little or no practical use, the relative rises in the two rivers varying with every flood.

At the close of the survey in 1889 a gauge had been fixed at a point 3 miles above Wetumpka Bridge, with its zero at low water, or 23 feet above low water at the bridge, and therefore less affected by the backing up before mentioned, except during very high stages. This had been read daily from that time until the end of November, when the recorder left the neighborhood, and there being no one living within a reasonable distance to continue the readings, a new gauge was erected about midway between the two points, with its zero at low water there, or 12.38 feet below that of the former and 10.52 feet above low water at the bridge.

To distinguish these gauges, the former is referred to as Gauge No. 1 and the latter as Gauge No. 2.

During a rise in the river both gauges record practically the same until 11-foot mark is reached, after which Gauge No. 2 shows a much quicker rise than No. 1; this being evidently caused by the backed-up water from the Tallapoosa having surmounted the rapids and reached the gauge.

The highest reading recorded on Gauge No. 1 during the winter was 28.5 feet, while at the same time Gauge No. 2 read 34 feet, and at the bridge the river reached 44 feet above low water.

Gauge No. 2 has been read from December 8 to the present time, except during an interval beginning January 30 and ending March 22.

The accompanying curve of gauge reading shows the fluctuations of the river at Gauge No. 1 from June 1, 1890, to May 31, 1891, inclusive.

On December 10 a favorable location was found on the river just above Gauge No. 1 for taking a series of discharge and velocity observations. The point chosen was in a straight reach with high parallel banks, about 600 feet apart at low-water level, where the rocky bed showed less inequalities than at any other point within several miles of Wetumpka. Both banks were cleared of a heavy growth of timber and canebrake, and by means of levels and soundings, 3 parallel cross sections 50 feet apart were taken of the river and banks. All three proving sufficiently uniform, ranging stakes were permanently established at the ends of each, and a base line laid off on the top of the west bank at right angles to the ranges, and carefully measured to a length of 300 feet from the middle one; at the end of this line an instrument point was permanently located. About 150 feet above the upper range a 1-inch manilla rope was stretched from bank to bank and hauled taut with an improvised windlass; the distance between low-water lines on this rope was divided into 13 parts and a tail rope attached at each point or about 46 feet apart.

Three extension rods of different lengths, on the principle of ordinary leveling rods, were made and weighted to float upright at depths varying from 3 feet to 30 feet, with the top just above the surface. The tops were painted white and a small red and white flag fixed to each to make it more conspicuous.

The method of taking the observations was as follows: The boat was first attached to the nearest tail rope to the west bank, and one of the rods extended so as to float

Digitized by Google

just clear of the river bed; to the top was attached a fishing line wound on a light wooden reel fixed in the stern of the boat, which was paid out by hand when the float was running, so that no check would be given to its impetus. When everything was ready the float was cast loose and allowed to drift downstream. On passing the upper range it was noted by an observer with a stop-watch, and a warning whistle given to the transit man at the end of the base line, who then followed its course until it crossed the middle range, when at another signal he clamped the instrument and noted the angle made with the base line. On passing the lower range a third signal was given and the watch stopped, when the number of seconds occupied in the passage between the upper and lower ranges were noted. The float was then wound in and the boat at the same time moved out to the next tail rope, when the operation was repeated, and so on until the last rope was reached. The whole series was then gone over again, sometimes as many as five series being taken at one stage.

It was the intention to repeat this, if possible, at every foot of rise and fall during the high-water season, but it was found that the river rose too quickly during the highest stages to permit this to be done during the rise; the fall, however, was much slower and a satisfactory number of these was obtained.

The results were plotted and the discharges calculated by means of a large scale diagram prepared for the purpose.

The accompanying cross section of the river is on the line of the middle range and shows the elevation of water surface at which the observations were taken and the corresponding discharges.

The observations were taken as often and as carefully as possible, and it is thought that the results obtained are as accurate as is consistent with the methods adopted.

As in the aforesaid distance of 5 miles included in the present project no stream of any importance enters the river, these results may be used in the computations for the height of guard walls of all three locks included in that distance; indeed there is no other suitable place for similar observations within convenient reach.

The following table gives the results obtained:

Guage reading.			Discharge, cubic feet per second.	Average velocity, feet per second.	Remarks.
Rising.	Falling.	Standing.			
.....	2.2	.....	8,033	2.09	Calm.
2.5	.....	.....	8,598	2.11	Moderate wind downstream.
.....	3.2	.....	10,126	2.38	Light wind upstream.
.....	.....	4.7	15,426	2.93	Do.
.....	4.9	.....	16,569	3.12	Calm.
.....	.....	5.5	18,835	3.29	Do.
.....	6.1	.....	21,750	3.56	Do.
6.2	.....	.....	22,243	3.62	Do.
6.6	.....	.....	25,198	3.84	Do.
.....	.....	6.7	24,168	3.77	Do.
7.3	.....	.....	26,638	3.91	Do.
.....	7.7	.....	29,210	4.15	Strong wind across stream.
8.2	.....	.....	31,620	4.26	Do.
.....	8.5	.....	32,174	4.30	Strong wind upstream.
.....	9.2	.....	36,722	4.62	Calm.
9.5	.....	.....	38,116	4.64	Do.
.....	10.0	.....	38,414	4.59	Do.
10.7	.....	.....	47,530	5.30	Do.
.....	10.8	.....	43,608	4.94	Strong wind downstream.
.....	11.0	.....	46,347	5.13	Calm.
.....	11.2	.....	47,923	5.22	Light wind across stream.
12.6	.....	.....	53,690	5.75	Calm.
.....	13.2	.....	52,104	5.05	Strong wind upstream.
13.4	.....	.....	58,414	5.56	Strong wind downstream.
.....	13.8	.....	56,357	5.23	Light wind downstream.
14.2	.....	.....	65,439	5.97	Light wind upstream.
.....	15.0	.....	56,864	4.97	Strong wind diagonally downstream.
.....	16.5	.....	67,276	5.16	Strong wind across stream.
17.2	.....	.....	72,907	5.53	Light wind up stream.
.....	17.7	.....	70,793	5.40	Strong wind diagonally upstream.
.....	18.6	.....	73,380	5.44	Light wind upstream.
.....	19.5	.....	79,011	5.57	Light wind diagonally upstream.
20.0	.....	.....	85,549	5.84	Calm.
.....	21.0	.....	73,159	4.88	Strong wind upstream.
.....	.....	21.7	85,794	5.53	Strong wind diagonally downstream.
.....	22.0	.....	80,182	5.07	Light wind downstream.
.....	23.0	.....	84,688	5.20	Light wind diagonally upstream.
23.4	.....	.....	109,041	6.38	Calm.
.....	25.4	.....	93,876	5.33	Strong wind across stream.
.....	.....	25.4	94,213	5.28	Calm.
.....	27.0	.....	103,255	5.48	Light wind diagonally upstream.
27.3	.....	.....	118,407	6.22	Strong wind diagonally downstream.
.....	28.5	.....	126,313	6.20	Calm.

Digitized by Google

The accompanying discharge and velocity curves have been prepared from the above results.

The detailed survey for the definite location of the three locks was commenced on December 16, and has been continued at every available opportunity since that time. The work, however, was very much delayed by the long continuance of almost incessant rains which fell from January to April, and which raised and kept up the river during the whole of that time. Twice it reached a maximum height of about 44 feet at the bridge and subsided very slowly, only reaching the 3-foot stage about the 10th of May, and remaining about the same throughout that and the following month.

The plans of the site of Lock No. 31 were completed about the middle of May, the lock and dam located on the same, and copies submitted for approval on May 29.

The survey at the site of Lock No. 30 was commenced at the latter end of May, and has been continued without interruption to the present time; except that, owing to the dense growth of timber and brush, an exceptional amount of clearing is required.

In my report on the survey of the river dated December 23, 1889, at the end of that portion headed "Physical characteristics of the river," the following statement is made: "It may be added that for the last 5 miles above Wetumpka the banks undergo another decided change; though still retaining their high precipitous faces, they are in that distance formed of alluvial soil instead of rock. * * * There is in the whole of the lower section an abundance of stone suitable for cribs, riprap, and rubble work, which can be obtained at very small cost for quarrying, and little or no transportation. At many points a good compact gneiss was found, suitable for masonry, though of course not so easily worked as the limestone in the river above."

Owing to the rapids and obstructions in the river, this gneiss can not be transported by water to the sites of the first three locks, and carriage by land will be extremely costly owing to the distance, and to the bad condition of the roads, or to the entire absence of such.

From time to time during the prosecution of the survey, examinations have been made in the neighborhood of Wetumpka, but they failed to disclose the presence of stone suitable for masonry, though there is an abundance suited, as before stated, for cribs, etc. Masonry stone will, therefore, in all probability, have to be brought to Wetumpka by rail from other sources.

The river and harbor bill of 1890 having fixed the size of the proposed locks at a length of 210 feet between heel-post centers by a width of 40 feet, while the project of improvement submitted to Congress called for a standard-sized lock of 322 feet by 52 feet, the following modified estimates of costs have been prepared to take the places of those designated in the report of the survey of 1889 as Table II, Table III, and Table V:

TABLE II.—*Estimated cost of a lock of the type proposed to be used, having a length of 210 feet between heel-post centers by a width of 40 feet, and a lift of 11 feet, which is the average lift of the total number of 27 locks.*

[The prices are based on the average of 8 of the tenders received for the construction of Lock No. 7, Great Kanawha River, West Virginia, and include all cost of supplying, fitting and placing the material in the locks.]

Class of work.	Quantities.	Rate.	Amount.
Cofferdam			$12,000.00
Excavation.....cubic yards..	10,000	$0.78	7,800.00
Rock excavation.....do....	400	2.39	956.00
Embankment.....do....	8,000	.42	3,360.00
Puddling.....do....	300	1.20	360.00
Concrete.....do....	994	7.18	6,777.92
Backing masonry.....do....	5,565	7.55	42,015.75
First-class masonry.....do....	3,408	10.97	37,385.76
Coping and quoins.....do....	342	17.20	5,882.40
Miter sills.....do....	60	15.45	927.00
Timber in guide cribs.....feet, B. M..	61,000	40.25	2,455.25
Stone filling in cribs.....cubic yards..	2,816	1.88	5,294.08
Paving slopes.....do....	1,736	2.59	4,496.24
Bolt holes in masonry.....linear feet..	1,056	.34	359.04
Total			130,069.44

Digitized by Google

TABLE III.—*Estimate of cost of crib and stone dams.*

[Prices include cost of all labor for the completed dams. Quantities are taken from design for dam, Lock No. 4, dated April 4, 1891; approved by the Chief of Engineers.]

Height of dam.	Lumber, $20 per M.		Iron drift bolts, 10 cents per pound.		Rock filling, $2.50 per cubic yard.		Earth and stone slope, $1.50 per cubic yard.		Total cost per linear foot of dam.
	Feet, B. M., per linear foot of dam.	Amount.	Pounds per linear foot of dam.	Amount.	Cubic yards per linear foot of dam.	Amount.	Cubic yards per linear foot of dam.	Amount.	
Feet.									
8	472.9	$9.45	43.8	$4.38	4.5	$11.25	1.0	$1.50	$27.08
10	624.5	12.49	61.5	6.15	6.1	15.25	1.8	2.70	36.59
12	703.0	14.06	66.0	6.60	8.6	21.50	2.8	4.20	46.36
14	873.8	17.47	79.6	7.96	11.6	29.00	4.0	6.00	60.43
16	969.9	19.39	84.9	8.49	14.8	37.00	5.5	8.25	73.13

TABLE V.—*Revised estimate of cost of the proposed improvement of the Coosa River, between Wetumpka and Lock No. 4, with locks 210 feet long between heel posts, by 40 feet wide.*

Number of lock.	Lift.	Lock.	Dam.	Dike.	Abutment.	Gates, valves, etc.	Lock house.	Channel work between locks, at $2.50 per cubic yard.	Total.
	Feet.								
31	13	$137,922	$29,433	.....	$5,000	$10,495	$2,500	.....	$185,350
30	10	126,369	36,258	.....	11,887	8,073	1,500	.....	184,087
29	8	118,218	9,272	.....	.....	6,458	2,000	.....	155,373
28	12	133,788	57,786	$19,425	11,887	9,687	2,500	.....	215,648
27	14	142,056	33,639	.....	11,887	11,302	2,000	.....	250,884
26	12	133,788	67,975	4,510	15,000	9,687	2,000	$3,300	236,260
25	10	126,369	78,812	.....	11,887	8,073	2,500	.....	227,641
24	10	126,369	40,083	.....	15,000	8,073	1,500	.....	191,025
23	14	142,056	58,504	.....	11,887	11,302	2,500	.....	226,249
22	12	133,788	54,387	.....	10,000	9,687	2,500	14,775	225,137
21	10	126,369	48,344	.....	.....	8,073	2,500	6,250	191,536
20	10	126,369	54,387	.....	15,000	8,073	2,000	.....	205,829
19	12	133,788	60,430	.....	.....	9,687	1,500	.....	205,405
18	13	137,922	90,645	.....	.....	10,495	2,500	.....	241,562
17	15	146,197	36,565	.....	11,887	12,109	2,000	675	209,433
16	14	142,056	51,191	.....	10,000	11,302	2,000	15,325	231,874
15	10	126,369	60,268	.....	10,000	8,073	2,500	.....	207,210
14	12	133,788	102,731	.....	.....	9,687	1,500	.....	247,706
13	12	133,788	120,860	.....	10,000	9,687	2,000	3,025	279,360
12	10	126,369	60,268	.....	10,000	8,073	2,000	2,000	208,710
11	10	126,369	32,931	8,100	.....	8,073	2,500	450	178,423
10	8	118,218	51,226	.....	15,000	6,458	2,500	3,225	196,627
9	8	118,218	58,544	.....	20,000	6,458	1,500	187,025	391,745
8	12	133,788	42,301	.....	23,775	9,687	2,500	.....	212,051
7	10	126,369	41,724	.....	23,775	8,073	2,500	.....	202,441
6	10	126,369	23,452	.....	15,000	8,073	1,500	119,613	294,007
5	8	118,218	34,157	.....	23,775	6,458	2,500	51,588	236,646
Total		3,521,287	1,486,173	32,035	292,647	241,376	57,500	407,201	6,038,219

From the above tables it will be seen that the reduction in the revised total estimate, by substituting the smaller lock for the larger one, of the original estimate, is $1,444,485 for the locks proper; while the estimate for the dams and abutments has been very largely increased, by $996,539 and $122,979, respectively, thus, assisted by some small reductions in the cost of the lock houses, making the reduction in the grand total only $36,694.

The increase in the cost of the dams and abutments is made in conformity with the modified plans for similar work at Lock No. 4, approved by the Chief of Engineers April 13, 1891; but there is no doubt whatever that these estimates are too high an average for the whole river, and that the detailed surveys, when made, would show many means of reducing them.

Digitized by Google

On the approval of the proposed location for lock and dam No. 31, at Wetumpka, it is proposed to expend the balance available during the coming year in acquiring the necessary land, in excavating the required channel through the rock ledge above the lock; in procuring plant and materials for work, and in obtaining, under contract if practicable, so much of the stone required for the construction of the lock as may be possible with the amount available.

ESTIMATES.

The subjoined estimate of cost of completing the existing project is based on the estimated cost of masonry locks 40 feet wide by 210 feet between miter sills, and on the estimated cost of the recently adopted designs for dam, abutment, and levee at Lock No. 4.

Money statement.

Amount appropriated by act approved September 19, 1890	$150,000.00
June 30, 1891, amount expended during fiscal year	8,681.34
July 1, 1891, balance unexpended	141,318.66
July 1, 1891, outstanding liabilities	823.45
July 1, 1891, balance available	140,495.21
Amount (estimated) required for completion of existing project	4,943,074.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Attention was first called to the improvement of this river by the opportunity which it offers, by canal connection with the Tennessee, for an outlet to the Gulf from the Upper Tennessee, as well as from the valley of the Coosa and its tributaries, and later, by the availability of the Coosa River as a link in the proposed line of water transportation from the northwest by the Mississippi and Tennessee to the Atlantic coast. In 1823 the State of Alabama passed an act in aid of the proposed work of improving the navigation of this river, with a view to its connection with the waters of the Tennessee, and in 1824 this act was finally approved by Congress. In 1828 the first appropriation by act of Congress was made for this improvement. A careful survey has demonstrated the practicability of the proposed connection between the Coosa and Tennessee by canal, but the estimated cost, which is nearly $12,000,000, has probably prevented action. It was the prospective navigation to follow the improvement of this river and its connection with the Tennessee which was originally considered in support of the project.

In the meanwhile the coal and iron interests of Alabama have been rapidly developed, and the Coosa River coal and iron fields have become the objective of the more recent plans of improvement. The extension of the improvement to Wetumpka will unquestionably build up a large traffic in coal, iron, and farm products between north Alabama and Mobile and intermediate points, and a large export business in coal from Mobile.

The present local business upon this river should not be taken as a measure of the value of this improvement.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

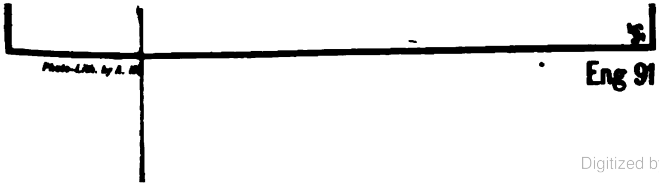
Digitized by Google

Digitized by Google

Digitized by Google

Eng 91
Digitized by Google

Digitized by Google



Digitized by Google

Digitized by Google

COMMERCIAL STATISTICS FOR COOSA RIVER, GEORGIA AND ALABAMA.

Stern-wheel steamboats.	Registered tonnage.	Draft of water.		Number of round trips made between—	Number of passengers.
		Light.	Loaded.		
		Inches.	*Feet.*		
Clifford B. Seay	115.80	16	5	Rome and Gadsden, 92...	1,980
Hill City	75.95	12	4	Rome and Gadsden, 15..	176
John T. Warlick	32.94	11	4	Rome and Carters, 40 ...	285

Freight carried.

	Tons.
Cotton, 16,500 bales	4,125
Cotton seed, 6,300 sacks	31½
Fertilizers, 23,000 sacks	2,300
Hides and skins, 75 packages	4
Live stock, 45 head	25
Lumber and staves, 2,350,000 feet	5,900
Grain, 6,000 sacks	45
Provisions	175
Miscellaneous freight	150
Total	12,755½

Estimated value of above freights (in round numbers), $775,000.

JNO. J. SEAY,
Rome, Ga.

P 12.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION ON COOSA RIVER, GEORGIA AND ALABAMA.

The expenses of operating locks Nos. 1, 2, and 3 during the past fiscal year have been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section, which requires the rendition of an itemized statement of such expenses, the following statement is submitted:

Statement of amount expended during the fiscal year ending June 30, 1891, out of the general appropriation for "Operating and care of canals and other works of navigation" in operating and keeping in repair locks Nos. 1, 2, and 3, Coosa River, Georgia and Alabama.

Lock No. 1:		
For wages of lock keeper	$600.00	
Extra labor, etc	29.02	
Tools, paints, oils, etc	181.20	
Rent of office	33.33	
		$843.55
Lock No. 2:		
Wages of lock keeper	600.00	
Extra labor, etc	29.02	
Tools, paints, oils, etc	181.20	
Rent of office	33 34	
		843.56
Lock No. 3:		
Wages of lock keeper	600.00	
Extra labor, etc	29.03	
Tools, paints, oils, etc	181.20	
Rent of office	33.33	
		844,56
Total		2,530.67

Digitized by Google

P 13.

IMPROVEMENT OF CAHABA RIVER, ALABAMA.

PLAN OF IMPROVEMENT.

Under an act of Congress approved June 23, 1874, and an act approved June 14, 1880, an examination and partial survey of this river was made in 1874, and a further examination and partial survey in 1880, pursuant to which the present plan of improvement was adopted.

This contemplates obtaining a channel 60 feet in width and 3 feet in depth, at low water, from its mouth to the town of Centreville, a distance of 88 miles, by the removal of snags, logs, etc., from the channel, cutting overhanging trees from the banks, protecting caving banks from further erosion, removing rock reefs and gravel bars by blasting and dredging and sand bars by works of contraction, and by widening narrow portions of the river at certain specified points.

This river, within the limits of the proposed improvement, has generally a movable bottom and caving banks with a mean slope of about 1½ feet to the mile, which increases at certain points to over 9 feet per mile. The improvement will have that degree of permanence which can be given by local works of contraction to rivers having such characteristics. An annual expenditure will be required for the removal of obstructions constantly accumulating in the channel and for the maintenance of the works; and a further extension of these works will be required.

APPROPRIATIONS.

August 2, 1882	$20,000
July 5, 1884	10,000
August 5, 1886	7,500
Total	37,500

OPERATIONS TO JUNE 30, 1890.

The appropriations to June 30, 1886, amounted to $30,000, and with this amount it had been practicable to build and equip a moderately efficient working plant to improve the river, according to the project adopted, from the mouth to a point below the bridge of the Alabama Central Division of the East Tennessee, Virginia and Georgia Railroad, a distance of about 19½ miles, and to make a partial improvement of the river to Centreville for high-water navigation by cutting the overhanging timber.

The expenditure of the $7,500 made for this improvement in the bill approved August 5, 1886, was prevented by a proviso that "no part of said sum shall be expended until the officer in charge shall have reported that the railroad and other bridges across said river have been provided with good and suitable draw openings."

WORK DONE DURING PAST FISCAL YEAR.

Although no changes have been made in the bridges across this river, and they still prevent its navigation by steamboats, the act of September 19, 1890, provided that "the existing provision restricting the expenditure of the balance now available for the improvement of said river is hereby repealed, and said balance shall be expended in continuing the improvement thereof."

Digitized by Google

In order to submit a project for the expenditure of the money thus made available an examination of the river was authorized.

This examination was made during November, 1890, by Assistant Engineer C. B. Percy, who is in local charge of the improvement, and who reported the condition of the river as follows:

At the time the examination was made in November the river was very near low-water mark, and all obstructions in the nature of logs, snags, rocks, bowlders, reefs, and sand and gravel bars were visible, and the general condition was as follows:

From Centreville to the foot of a rock reef, about 11¼ miles, the river had undergone no material change, the regimen being comparatively permanent, but the chutes and reaches were all found full of logs and fallen-in timber and banks covered with over-hanging trees.

From this point to Fike Ferry, a distance of 33.65 miles, the character of the river is greatly altered, and shows marked changes since 1880, and even since 1886, when the work was suspended. It is filled with a succession of large sand and gravel bars and shoals, having short reaches between them and the channel, shifting with every freshet; the banks are caving rapidly and both chutes and reaches so filled with logs, snags, and fallen-in timber as to be in some places almost impassable. From Fike Ferry to the bridge of the East Tennessee, Virginia and Georgia Railroad, a distance of 21¼ miles, fewer alterations were found, the sand and gravel bars, though still numerous and large, appear to be subject to less change; the banks were stable and fairly free from overhanging timber and channel found clearer of logs and snags. From Centreville to this point, a total distance of 66.65 miles, is that portion that had been improved by cutting and removing overhanging timber for high-water navigation. From the bridge to the entrance of the Cahaba into the Alabama River, a distance of about 31¼ miles, the regimen of the river is comparatively permanent The high, soft, or rotten limestone bluffs are now met with, and most of the shoals are of the same material; the reaches are long stretches, having moderate current and, as compared with other portions of the river, pretty free of logs and snags and with but little overhanging timber. This portion of the river was improved to low-water navigation, and beyond the incidental accumulation of logs and snags was found to be about as it was in 1886.

The bridges across the river are still without draws.

The river in its present condition is not adapted at a low-water stage to any sort of navigation, and at high water only to rafts and flatboats.

It was then decided, with the approval of the Chief of Engineers, to construct a small light-draft log-boat suitable for work on this river. The plans and estimates for this boat having been approved, orders for supplies and materials were given early in February and March, but the work of building was delayed on account of continued high stage of the river. It was commenced by day labor on April 15, and it is expected that the boat will be completed and ready for work in July, 1891.

The boat will be of sufficiently light draft to be used at any stage of water. It is supplied with a powerful steam capstan and derrick, with swinging boom, and will be well adapted for this work.

RECOMMENDATIONS AND ESTIMATES.

Whether this river would be used by steamboats for commercial purposes, provided the bridges now obstructing it were provided with draw openings, is not known.

It is believed that the present demand for the clearing out of the river comes mainly from persons engaged in the timber trade, who desire to use the river for rafting purposes.

It is impossible to submit an estimate of the cost of completing the existing project without more careful surveys than the funds available justify.

If the improvement of the river is to be continued, the sum of $20,000 can be profitably expended during the fiscal year ending June 30, 1893.

Digitized by Google

Money statement.

July 1, 1890, balance unexpended	$7, 770. 35
June 30, 1891, amount expended during fiscal year	3, 506. 56
July 1, 1891, balance unexpended	4, 263. 79
July 1, 1891, outstanding liabilities	2, 004. 29
July 1, 1891, balance available	2, 259. 50
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	20, 000. 00

COMMERCIAL STATISTICS.

The census of 1880 gives for the counties bordering upon this river within the limits of the proposed improvement a total assessed valuation of real and personal property amounting to $9,118,034, and a total taxation of $156,526.

No steamboats have navigated this river for several years, and but very few barges. The entire cotton crop of this section, estimated at 40,000 bales, was formerly flatboated down the Cahaba to the Alabama River; but of late years, owing to its bad condition, very little cotton or other produce has been thus carried to market.

Estimated value of commerce.

40,000 bales of cotton, $40	$1, 600, 000
Cotton seed, corn, hay, etc	500, 000
Return merchandise, etc	1, 720, 000
Total	3, 820, 000

In addition to the above, a large amount of sawn and hewn timber and saw logs of oak, cypress, and pine is annually rafted out of this river to Mobile via the Alabama. No record is kept of this business, so no estimate can be made.

P 14.

PRELIMINARY EXAMINATION OF CHATTAHOOCHEE RIVER, GEORGIA AND ALABAMA, BETWEEN WEST POINT AND FRANKLIN.

[Printed in House Ex. Doc. No. 134, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 29, 1890.

SIR: I have the honor to submit the accompanying copy of report, dated December 4, 1890, by Capt. Philip M. Price, Corps of Engineers, giving results of a preliminary examination of "Chattahoochee River, Georgia and Alabama, between West Point and Franklin," made in compliance with the requirements of the river and harbor act approved September 19, 1890.

Captain Price is of the opinion that Chattahoochee River between West Point and Franklin is worthy of improvement; but Col. C. B. Comstock, Corps of Engineers, Division Engineer of the Southwest Division, in view of the cost of improvement and the present and prospective wants of commerce, does not think the locality worthy of improvement at this time. I concur in the views of Colonel Comstock.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

Digitized by Google

REPORT OF CAPTAIN PHILIP M. PRICE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., December 4, 1890.

GENERAL: I have the honor to submit the following report of the preliminary examination of the "Chattahoochee River, Georgia and Alabama, between West Point and Franklin," required by the act of September 19, 1890.

The examination was made in November, 1890, by Assistant Engineer Thomas Robinson, whose report is forwarded herewith. The examination was made by going down the river from Franklin to West Point in a skiff, at a very low stage of water, which afforded an excellent opportunity for observing the obstructions to navigation and enabled a fair judgment to be formed as to the character of the improvements required.

An examination and partial survey of the Chattahoochee River from Gainesville, Ga., to Columbus, Ga., which includes the section between West Point and Franklin, was made in 1879 under the direction of Lieut. Col. (then Major) W. R. King, whose report is printed at page 1705 of the Report of the Chief of Engineers for 1880. This report states that the improvement of the section of river from the Western and Atlantic Railroad Bridge, near Atlanta, to West Point, a distance of 108 miles, appears entirely feasible, at an estimated cost of $486,474, which includes the cost of eight locks. The distance from West Point to Franklin is about one-third of the above distance, and Assistant Engineer Robinson thinks it probable that only one lock will be required in this stretch of river examined by him. This indicates that the cost of the improvement of the river between West Point and Franklin may be about $100,000, but a careful survey is needed in order to submit a satisfactory estimate.

The section of the river under consideration has stable banks and rock bottom, with no sand or gravel bars, and any improvement will therefore be of a permanent character. The normal low-water width of the river is stated to be about 300 feet, with a sufficient volume of water to furnish a 3-foot channel at the lowest stages.

The improvement of the river between West Point and Franklin would afford cheap water transportation to a market or railroad at West Point for the products of five counties of Georgia and Alabama. The assessed wealth of these five counties is $10,209,017 and the total taxes paid by them $63,019.60. West Point is an important and growing manufacturing and shipping point. Two steam freight boats with a total capacity of 160 tons now navigate the river at favorable stages of water, from a point 7 miles below West Point to Bentley Mills, 12 miles above.

The Chattahoochee Navigation Company, chartered by the State of Georgia, and composed of citizens of West Point and Franklin and intermediate points, have already expended about $13,000 in improving some of the reefs in the river. This company intends to build two new steamboats, each 110 feet by 20 feet, capable of carrying 80 tons each.

In view of all the circumstances of the case, the feasibility, permanence, and probably small cost of the improvement, and the present and prospective commerce to be benefited, I concur in the opinion of Assistant Engineer Robinson, that this portion of the Chattahoochee River is "worthy of improvement," and recommend that it be surveyed.

Digitized by Google

The cost of a satisfactory survey, including the preparation of plans and estimates, is estimated at $1,500.

Very respectfully, your obedient servant,

PHILIP M. PRICE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 18, 1890.

Respectfully forwarded to the Chief of Engineers.

It appears from the papers herewith that the Cattahoochee, between West Point and Franklin, a distance of about 36 miles, is obstructed by numerous shoals and ledges; has no navigable connection with the lower Chattahoochee, and, if improved, that the improvement must be by a lock or locks and dams.

For these reasons, and in view of the present and prospective wants of commerce, I do not think it worthy of improvement, at present, by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. THOMAS ROBINSON, ASSISTANT ENGINEER.

FORT MITCHELL, ALA., *November 24, 1890.*

CAPTAIN: In accordance with instructions contained in your letter of September 24, I have made an examination of the Chattahoochee River between West Point and Franklin, Ga., and I respectfully report the following:

The examination was begun at Franklin and continued down the river to West Point.

The appropriation was limited, and no instrumental measurements, with the exception of occasional soundings, could be attempted. All distances, elevations, or falls are, therefore, eye estimates; but the figures herein given are designed to be maxima.

About 15 miles of the river were passed over during a dense fog, and so only a portion of the width could be seen.

Where islands occurred the boat was directed into what, as seen from the upper side, appeared to be the better channel, and it is possible that the run thus followed was, in any case, not the better of the two.

The examination was made when the river was about 1 foot above extreme low water—a very favorable stage for observing the ordinary low-water conditions.

Geologically considered, the bed of the river lies in metamorphic rock, ranging in quality from a tough, fine-grained granite to a readily cleaving mica schist. The banks of the stream are mainly rockbound and permanent. No caving banks were seen, and no sand or gravel bars were found. Snags and logs were scarce and only the rock obstructions are to be considered in any plan adopted for the improvement of this water way.

Ordinary high water is from 7 to 10 feet above the low-water line. In time of extreme freshet the river has been as high as 22 feet above low water.

Taken in order downstream, and beginning 1 mile below the county bridge at Franklin, the obstructions are:

(1) Featherstone Shoals, estimated to be half a mile long and to have a fall of 2 feet; ledges and scattered bowlders; channel crooked. The probable remedy would be to remove rocks and deposit the same in wing dams and dikes.

Digitized by Google

(2) Lane Shoals, estimated to be 1 mile long and to have a fall of 1½ feet; bowlders, grouped chiefly at two points. Probable remedy, remove rocks only.

(3) Lenville Shoals, estimated at three-fourths of a mile in length, with a fall of 1 foot; scattered bowlders, and in two places narrow ledges. Probable remedy would be to open channel through the ledges.

(4) Jackson Shoals. These are reallytwo shoals with a quarter-mile reach of good water between them, estimated to be one-half mile long and to have a fall of about 6 feet. These shoals have in times past been used as mill sites, and the old dams make the natural obstructions appear more formidable than they actually are. By utilizing these old dams and supplementing them with excavations and wing dams it is judged that these shoals can be surmounted without resort to lock structures.

(5 and 6) Daniels and New River Shoals were passed during a fog. As seen they appeared to be small obstructions, requiring little or no work to render them passable by boats.

(7) Philpot Shoals, upper and lower, appeared small as seen through the fog.

(8 and 9) Shoals unknown; rocks apparently few and scattered.

(10) Shoal unknown; extending, it seemed, for half a mile downstream; bowlders and ledges; the chief impediment appeared to be a narrow ledge reaching all across the river.

(11) Swanson Island Shoals, estimated to be one-fourth mile in length and to have a fall of 1½ feet. A probable remedy would require only the removal of rocks.

(11 A) Bridge, upper Troup County, wooden lattice, four stone piers; channel spans estimated to have a clear width of 100 feet and a low-water headway of 25 feet.

(12) Ringer Shoals, estimated at an eighth of a mile in length and to have a fall of 1 foot; scattered reefs and bowlders, the latter grouped in two places. A probable remedy here would require the removal of rocks and deposit the same in a small dam.

(13) Boykin Shoals, water much broken; but apparently with scattered bowlders only. The fall was estimated at 1 foot.

(14) Shoal at lower end of two islands, having an estimated fall of 1½ feet. It is possible that in following down the left bank the boat did not take the better channel; but, as found, the obstructions were a ledge and scattered bowlders.

(15) Reed (?) Island Shoals, having an estimated fall of 1½ feet, bowlders and ledges. The boat followed the left-hand run, and only channel that was seen.

(16) McGee (?) Shoals extend for half a mile in scattered bowlders; but appear to require no work to free the channel.

(17) Reed (?) Island No. 2, Shoals, a narrow ridge of ledge and bowlders extending across the river; the fall is estimated at one-half foot. The probable remedy would be to cut through the ledge.

(17 B) Bridge—Lower Troup County—wooden lattice, 4 stone piers, channel spans estimated at 100 feet clear width, and a low-water headway of 25 feet.

(18) Bentley Mills Shoals. These shoals extend all across the stream, and are topped with a timber and rock dam, making a fall of 6 feet. The dam, however, forms slack water with a navigable channel for 6 miles above, where otherwise shoals would appear. The remedy here is evidently the insertion of a lock with a lift of about 8 feet.

(19) Huguly Shoals, about one-half mile long, with an estimated fall of 1½ feet, consist of broken reefs and scattered bowlders. The remedy would probably consist of excavating rock and dumping the same to form wing dams and dikes.

(20) Ferrell Shoals have an estimated length of half a mile, with a fall of 2 feet, and consist of small islands, ledges, and scattered bowlders. The islands form natural canals, from which, if the rocks are removed and deposited as dikes, a navigable channel can apparently be secured without a lock.

(21) Pott Shoals, taking the upper and lower together, are estimated at a half-mile in length with a fall of 2 feet. The obstructions consist of ledges and bowlders. A probable remedy would be the removal of rocks and the deposit of the same as dikes and wing dams.

(22) Hutman Island and Flat Rock Shoals are similar to the preceding.

(23) Below Flat Rock Shoals, and scattered along a distance of about 6 miles, lie three or four small reefs and loose bowlders, but apparently of no serious obstruction to navigation.

(23 C) Bridge—the Atlanta and West Point Railroad—is an iron truss of 5 spans resting on stone piers, with no draw opening. The axis of the bridge is oblique to the current. The channel spans have a clear opening of about 100 feet, with a low-water headway of 23 feet. The examination ended at this bridge, but the river is navigable for a distance of 7 miles further down.

Between West Point and Franklin the river lies within the State of Georgia, but two counties (Randolph and Chambers) of Alabama lie so close to the stream that their interests are equally affected.

The following statement, obtained in reply to oral and written questions, and cer-

Digitized by Google

tified to by reliable men, shows fairly the commercial value, condition, and needs of the counties bordering this water way:

Population as per census of 1880.

Georgia:		Alabama:	
Heard County	8,769	Chambers County	23,440
Troup County	20,565	Randolph County	16,575
Harris County	15,758		

Total assessed wealth of these five counties $10,209,017.00
Total taxes paid by these five counties 63,019.60

(Official data from comptroller-general of Georgia and the secretary of state of Alabama.)

"The annual commerce and clearings of the banks at West Point, Ga., aggregate $10,000,000."

In West Point and vicinity there are three cotton mills, having a total of 24,700 spindles, 446 looms, and a yearly consumption of 17,000 bales; and one cotton seed oil mill, with a daily capacity of 30 tons of seed. There are also a foundry, machine and variety works, and several sawmills, all of whose separate values and capacities were not obtainable. The combined capital of all these mills, foundry, etc., aggregates $750,000.

The natural resources of these counties are rich farm lands, forests of pine, oak, ash, walnut, and maple. Minerals consist of manganese, kaolin, copper, mica, and asbestus, and a fine quality of granite in Heard County.

Two steam freight boats having a total capacity of 160 tons now navigate the river, at favorable stages of water, between the cotton factories located 7 miles below West Point and Bentley Mills, 12 miles above.

Flatboats carrying 25 tons have been run from Franklin to West Point. Railway ties and logs have been rafted; but the rock-obstructed channel, except at favorable high-water seasons, renders rafting an unprofitable business.

The citizens of West Point and Franklin, and places between, have formed a sort of mutual river-improvement society, and to give the scope of the enterprise I quote from a letter signed by the officers of the company:

"The Chattahoochee Navigation Company, chartered by the State of Georgia—L. Lanier, president, Arthur Heyman, secretary and treasurer, J. S. Baker, L. S. Turner, M. Herzberg, directors (all of West Point), and T. C. Lanes, F. D. Loftin, and J. H. Daniels, directors (all of Franklin)—purposes to run a line of steamboats between Franklin, Heard County, Ga., and West Point, Troup County, Ga., and to remove" [* from the river] "all obstructions thereto. This corporation has expended about $13,000, and will expend about $22,000 more for this enterprise. They have made a safe channel" [* at moderate stage of water] "of 3 feet by 50, through Magnolia Shoals, Todd Shoals, Roberts Shoals, Flat Rock, Pott and Ferrell shoals, and are now putting in a lock at Bentley Mills."

* * * * * * *

"The work is also being prosecuted at the Franklin terminus, having secured a channel through Featherstone Shoals and begun work on Jackson Shoals."

* * * * * * *

"The business of Franklin and section bordering on the river represents the production of 30,000 bales of cotton, all of which would reach a market on steamboats down the River to West Point. With such proposed facilities for marketing this crop the money value of the same would be increased to the producers at least 20 per cent. Heard County, rich in timber and minerals, besides being a fine agricultural section, is without any transportation facilities. Franklin, its county seat, situated on the Chattahoochee River, is 18 miles from the nearest railroad and 38½ miles by river from West Point. Plantations on both sides of the river need facilities for procuring fertilizers, machinery, and other supplies at convenient landings, and to enable them to send their minerals, lumber, cotton, and other produce to some distributing point, and thus to open up the resources of this section of these two States. The Chattahoochee Navigation Company intend building two more steamboats 20×110 feet, capable of carrying 80 tons each."

All materials necessary for the improvements can be readily obtained from the river itself.

When complete, the improvement will require no outlay for maintenance except, possibly, the employment of one or more lock tenders.

As a local measure the improvement would be of great immediate service, and it is almost a necessity for the future development of the surrounding counties in the States of Georgia and Alabama.

* Words in brackets are mine.—T. R.

Digitized by Google

As a link in a chain of through commerce the matter can not be considered until the Chattahoochee River between West Point and Columbus, a distance of about 25 miles, is open to navigation.

So far as this examination has shown, I deem the improvement of the Chattahoochee River between West Point and Franklin, Ga., to be practicable in undertaking, economical in cost, permanent in results, and a necessity for the present and future good of the surrounding country. I therefore recommend that a detailed survey be made to determine more fully the actual facts in the case.

The cost of such a survey and the preparation of plans and estimates is estimated at $1,500.

Yours obediently,

THOS. ROBINSON,
Assistant Engineer.

Capt. PHILIP M. PRICE,
Corps of Engineers, U. S. A.

P 15.

PRELIMINARY EXAMINATION OF ALABAMA RIVER TO ASCERTAIN COST OF SECURING A 6-FOOT CHANNEL AT LOW WATER FROM MOUTH TO WETUMPKA, ALABAMA.

[Printed in House Ex. Doc. No. 140, Fifty-first Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., December 10, 1890.

GENERAL: I have the honor to submit the following report of an examination of the "Alabama River to ascertain cost of securing a 6-foot channel at low water from mouth to Wetumpka," required by act of September 19, 1890.

NAVIGABLE MILEAGE OF THE ALABAMA RIVER WITH ITS TRIBUTARIES.

The mouth of the Alabama River is regarded as situated at its junction with the Tombigbee River, where the two rivers form the Mobile River, 44 miles above Mobile.

The Alabama River is formed by the junction of the Coosa and Tallapoosa Rivers, at an estimated distance of 312 miles above the mouth of the Alabama. The Tallapoosa River is a navigable stream from its mouth to the foot of the Tallassee Reefs, a distance of 48 miles. The Coosa River is now navigable from its mouth to the foot of the rapids at Wetumpka, a distance of 11 miles. From Wetumpka to Lock 4, a distance of 116 miles, the Coosa River is obstructed by rock reefs and shoals and is not now navigable, but the improvement of this section of the river, by a system of locks and fixed dams, combined with rock excavations in the channel, has been authorized by Congress, and an appropriation of $300,000 was made by the act of September 19, 1890. On completion of the dam now under construction at Lock 4 the Coosa River will be navigable from this point to Rome, Ga., a distance of 188 miles. At Rome the Oostenaula and Etowah rivers unite to form the Coosa River. The Ostenaula River and its tributary, the Coosawattee River, are navigable, at moderate stages of water, for an estimated distance of 105 miles above Rome. There are now, therefore, stretches of 293 miles of navigable river above Lock 4, and 367 miles below Wetumpka, and when the improvement, now in progress, of the 116 miles between Lock 4 and Wetumpka is completed, there will be a continuous route of good water transportation from the timber, coal, iron, and other mineral fields of North Georgia and Alabama, through the rich agricultural and timber regions of Middle and South Alabama to the Gulf of Mexico.

Digitized by Google

At a distance of 196 miles above its mouth the Cahaba River flows into the Alabama.

The improvement of the Cahaba River from its mouth to Centreville, Ala., a distance of 88 miles, by snagging operations and deepening the water on the bars by works of contraction, has been authorized, and is now under way. A project for the further improvement of the Cahaba River from Centreville to Shades Creek, a distance of 23½ miles, by locks and dams, in order to afford an outlet to the immense deposits of coal and iron ore in that region, was submitted by Maj. A. N. Damrell, Corps of Engineers, in 1881 (see page 1232 report of Chief of Engineers, 1881), but the carrying out of the project has not been authorized by Congress.

SURVEY OF 1875.

In 1875 an examination and partial survey of the Alabama River from its mouth to Wetumpka was made under the direction of Maj. A. N. Damrell, Corps of Engineers, by Assistant Engineer G. B. Yuille. the report of which is printed in the Annual Report of the Chief of Engineers for 1876, page 498.

Assistant Engineer Yuille gives the following description of the river at the time of his survey:

Commencing at Wetumpka, which is situated at the head of an open reach of navigable water on the Coosa River and at the foot af the last of a series of rapids that obstruct the upper portion of that river, with a width here of 400 feet between fixed and stable banks partly formed of gneiss rock, through which the river has made its way, it assumes a lake-like appearance, maintaining a uniform width, with a very moderate current and depth of not less than 6 feet, till the mouth of the Tallapoosa River is reached, the junction of which with the Coosa forms the Alabama River proper.

At the mouth of the Tallapoosa we come upon the first serious obstacle to navigation, caused by an extensive deposit of coarse gravel in the channel of the united rivers, brought down the former in times of flood, filling up the bed and causing a widening of the main river, with a consequent dispersion of the water into several shifting channels, through which only about 2 feet depth is found at low-water stage.

* * * * * * *

This disturbance of the otherwise favorable condition of the river continues for about 3 miles, when the normal character of the river is again found, with an increase of width to 500 feet since the accession of the Tallapoosa, and with a depth of from 6 to 15 feet in all open reaches of the river.

We now enter upon a portion of the river that is very uniform in its characteristics, in the character of the banks, width, and depth; also in the great similarity and nature of the obstructions found. This similarity continues so long as the river is bounded one side or the other by high and solid bluffs.

* * * * * * *

The banks generally of the upper portion of the river are of a solid and firm nature, and in no case was there found any extensive caving or falling in. In a very large proportion the banks upon one side of the river or the other are composed of a compact soft rock or marl, usually called rotten limestone, a material that offers an effective barrier against the eroding action of the river, and which often contains ledges of a harder material, fit in many places for building stone. The bluffs also contain large quantities of nodules or concretions of a hard and solid character that fall from the face of bluff and collect at the edge of low water, that would make suitable material for filling cribs of dams and jetties, easily gathered by boat at low water.

This general character of the river, however, is only applicable to those parts that are free from islands, bars, and shoals, of which there are great numbers, as shown upon the index map. These obstructions may be said to have resulted from the failure in resistance offered to the action of the river by one or the other of the banks, allowing an increase of width in the flood stage, and the consequent filling by timber, gravel, and sand in the unduly widened river bed during the subsidence of flood. This action has in the course of time divided the channel, forming islands and bars with those in a less advanced state, constituting the present shoals.

The foregoing description of character of river applies to that portion commencing near the mouth of Tallapoosa River, and extends to a point between Claiborne and

Digitized by Google

Gainestown, where the high bluffs come to an end. The width of the river in this portion ranges from 500 to 600 feet, and wherever that width is exceeded will be found the bars and shoals. In the open reaches of river ample water is always found, ranging from 8 to 15 feet and often much deeper. At none of the bars or shoals was there found any excessive current, and in the open reaches the current did not exceed three-fourths or 1¼ miles per hour.

In this really beautiful portion of the river its usefulness is marred by many bars, shoals, and reefs, and collections of logs, at many of which points the low-water depth is reduced to 3½ and even 2½ feet.

We now come to that part of the river between Gainestown and the mouth, where the width has increased to 600 and 800 feet, the depth ranging from 10 to 12 feet in the fair reaches, and upon the shoals as low as 3 feet was found for low water.

From near this point, where the high bluffs terminate, the river banks are mostly overflowed in high water, and are more subject to erosion by the river; a much wider scope of the valley of the river is overflowed, and we find a sudden falling off of the oscillation.

* * * * * * *

The average rate of inclination of the river from the cut-off to Montgomery is 0.328 feet, or about 4 inches per miles; from Montgomery to Wetumpka, 0.469 feet, or 5⅝ inches per mile.

At the most rapid part of the Tallapoosa Shoal the mean velocity was determined by measurement at 4.56 feet per second, or 3.1 miles per hour, which extended about one-quarter of a mile in distance at that rate. At no other point on the river was there found such an exceptional mean velocity; therefore, without burdening this report with more data for determining the exact capacity of the river, we may safely proceed to consider plans and estimates of cost, being fully satisfied that there will be abundant volume of water to carry out any scale of improvements contemplated, or the requirements of probable commerce on the river may call for.

PLANS AND ESTIMATES SUBMITTED IN 1876.

As a result of the survey of 1875 two estimates were submitted for the improvement:

(1) For obtaining a channel 200 feet wide and 4 feet deep at low water, at a cost of $229,741.

(2) For obtaining a channel 150 feet wide and 6 feet deep at low water, at a total cost of $459,773.25.

Major Damrell recommended the first estimate "as giving all that is needed at present, and should the future commerce on the river demand a greater depth, as is very probable, the money expended in carrying it out will be judiciously expended for executing the second project."

This recommendation was approved, as was also the method for effecting the improvement by the removal of snags, logs, etc., from the channel; cutting overhanging trees from the banks; removing rock and gravel reefs by blasting and dredging, and deepening sand bars by works of contraction and shore protection.

Major Damrell estimated the cost of removing the annual accumulations of logs and snags from the river and of keeping the jetties and other auxiliary works in repair at $10,000 a year.

APPROPRIATIONS.

The following appropriations for improving the Alabama River have been made:

June 18, 1878	$25,000
March 3, 1879	30,000
June 14, 1880	25,000
March 3, 1881	20,000
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	15,000
August 11, 1888	20,000
September 19, 1890	20,000
Total	185,000

Digitized by Google

WORK DONE.

Under the approved project work was begun in 1878 and continued during the low-water season of each year until 1883. During this period of five years the average annual appropriations were $22,000, and with this amount considerable snagging work was done, and dams or jetties built of brush and stone, rock, or pile work and stone were constructed at eight of the most troublesome bars, viz, the Cut-off, Haines Island, Hobbs Island, Yellow Jacket, Gardners Island, Hadnots, Coxs and Three Chutes.

During the past 7 years the average annual appropriations (excluding the appropriation of September 19, 1890) have been but $7,857.14, which have not sufficed for the proper maintenance of the improvement, and nearly all the jetties and dams are much in need of repair. A great deal of useful work has, however, been accomplished by the removal of logs and snags from the channel and by cutting and trimming overhanging trees. Many of the shoal places in the river are caused by the accumulation of sand and gravel about sunken logs and snags, and a number of the troublesome bars have been permanently improved simply by the removal of these obstructions, without resorting to jetties and wing dams.

Before the improvements were begun in 1878 the river was so full of sunken logs and snags and so obstructed by bars and shoals, on many of which the low-water depth was only 2½ to 3½ feet, that navigation was both difficult and dangerous, and many boats were destroyed by striking snags. At low-water stages boats could only run by daylight, and long detentions at the bars and shoals were frequent, 2 or 3 weeks being oftentimes occupied in the trip between Mobile and Montgomery.

Now, the least depth in the bars has been increased to 4 feet, and the boats run by night as well as by day, at all stages of water, carry greater loads, and regularly make the round trip from Montgomery to Mobile and return in one week.

PRELIMINARY EXAMINATION AND REPORT BY ASSISTANT ENGINEER C. B. PERCY.

In September and October, 1890, Assistant Engineer C. B. Percy, who has been in local charge of the Alabama River improvement since May, 1889, was at work on the river with the sternwheel snag boat *W. J. Twining*, and passed over the entire distance from Wetumpka to the mouth. I had directed Mr. Percy to take advantage of this opportunity to make the preliminary examination required by the act of Congress, which was by this means accomplished without extra cost.

Mr. Percy's report is appended, and attention is respectfully invited to it and to the tabular statement of bars, shoals, etc., which forms part of it, for detailed information as to the present condition of the river.

I concur in Mr. Percy's opinion that a further detailed survey of the river is not now necessary. Such a survey would be quite costly, and were the improvement authorized much of it would have to be duplicated, for the reason that the form and extent of the bars are constantly changing, and a detailed plan of improvement for any particular locality which might now be decided upon would in all probability require modification a year hence. The survey and estimates of Assistant Engineer Yuille and the improvements since effected, together with the examinations and surveys which have been made from time to time

Digitized by Google

in the past 18 months by Assistant Engineer Percy, show beyond doubt that it is entirely feasible to secure a 6-foot channel at reasonable cost, and, in the opinion of Mr. Percy, in which I concur, furnish sufficient data to justify him in submitting the following estimate of the cost of extending the present plan of improvement to secure this object.

This estimate includes the cost of making such detailed surveys as may be needed from time to time of localities to be improved by works of contraction, such surveys to be made when funds are available for the works. The estimate does not include the annual cost of maintaining the improvement. It is estimated that $10,000 will be required annually for snagging operations and for keeping the jetties, dams, etc., in repair.

ESTIMATE OF COST TO SECURE 6-FOOT CHANNEL.

For works of contraction and shore protection	$305,871
For snagging operations	30,000
For supervision, surveys, and contingencies, 15 per cent	50,380
Total	386,251

This estimate assumes that sufficiently large appropriations will be made to secure a suitable working plant and to prosecute the work vigorously without interruptions on account of lack of funds. To carry on the work economically appropriations of at least $100,000 per annum should be made.

PRESENT AND PROSPECTIVE DEMANDS OF COMMERCE.

It is estimated that the commerce of the Alabama River has doubled in value since 1884, when it was reported at $4,438,732. It has been impossible to obtain figures as to the tonnage and value of freights either from the agents of the steamboat lines or from the secretaries of commercial associations who have been requested to furnish them.

The following is a statement of the boats employed in the river trade:

	Draft light.	Draft loaded.	Net tonnage.
Passenger and freight steamers (stern-wheel):	*Inches.*	*Feet.*	*Tons.*
Nettie Quill	26	5	350
Carrier	20	4	200
C. W. Anderson	24	5	250
Binsle Moore	20	5	200
Trade boat (stern-wheel):			
Minnie Lee	16	4	150
Barges:			
Capt. Sam	14	3	150
"People's Line"	15	3	150
Aggregate tonnage			1,450

Three of these boats each make round trips weekly between Montgomery and Mobile, and in addition to the freights carried by them a large amount of timber is transported in rafts.

A conservative estimate of the value of the commerce during the past year places it at $10,000,000. The present large and growing commerce of the river would be greatly benefited by having a 6-foot channel, which would enable the boats to be fully loaded at all stages of

Digitized by Google

water. At present during the low water of the fall season, when the cotton crop is being moved, full loads can not be carried.

On the completion of the Coosa River improvement, the Coosa and Alabama rivers will become the natural route for the transportation of the coal and iron of the Coosa River territory to the Gulf of Mexico. This traffic will be carried on in barges, and for its profitable development a 6-foot channel is required in both rivers.

As required by the law, I have the honor to state that in my opinion the Alabama River is "worthy of improvement," as proposed.

Very respectfully, your obedient servant,

PHILIP M. PRICE,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 18, 1890.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion of the district officer, that this river is worthy of improvement, for the reasons stated herein.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. C. B. PERCY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Montgomery, Ala., November 5, 1890.

CAPTAIN: In accordance with your letter of September 24, 1890, I have the honor to herewith submit the following report as to the necessity of a further survey of the Coosa and Alabama rivers, with a view of ascertaining the practicability and the estimated cost of a 6-foot channel from Wetumpka, situated at the foot of the reefs in the former, to the mouth of the latter, a distance of 322½ miles.

A disconnected instrumental survey, between the limits above specified, was made under the direction of Maj. A. N. Damrell in 1875, and the report is to be found in that of the Chief of Engineers of 1876, page 499, part I.

The amount allotted for the examination at that time did not justify any extended or connected survey. Consequently only the more important obstructions were carefully investigated, a cursory examination of the smaller islands, bars, and shoals made, and the reaches of the river merely sounded. While the detailed features of all the bars have materially changed since that date, the general characteristics have remained unaltered, so that the information and data then secured, and that furnished by the surveys of the more important bars, etc., made during 1889, together with the knowledge of the river gained during the progress of the present improvement, will furnish as accurate and reliable data upon which to base an estimate of cost and a general project for a 6-foot channel as would be gained from any survey made at this time, for by the time the funds for starting the work would be made available other alterations will have probably taken place, rendering a survey of each locality necessary before determining on the plan of improvement. Therefore I would respectfully suggest that no survey be made now, and that a sufficient amount be added to the estimated cost to cover the expense of such examination as may from time to time be required.

The estimated cost of improving the channel of these rivers to a depth of 4 feet from Wetumpka to the mouth of the Alabama was, according to the report of 1876, $229,741.

Digitized by Google

The total amount appropriated toward this improvement up to June 30, 1890, was $165,000, and the work done has resulted in securing a depth of 4 feet at low water, permitting an uninterrupted navigation during the entire year to boats of that draft, and to those drawing 5½ feet or less during 9 months, and also in securing a channel comparatively free of logs and snags, and in clearing the banks of overhanging timber dangerous to navigation, whereas, at the time the survey was made, "its usefulness was marred by many bars, shoals, and reefs, and collection of logs, at many of which points the low-water depth is reduced to 3½ and even 2½ feet." The entire river was much obstructed by logs and snags that were embedded in the main channel and chutes, and the banks lined with dangerously overhanging timber. A very large portion of the amount so far appropriated has been expended in removing the logs and snags and overhanging timber, also in maintaining the improved condition of the river by the removal of the annual accumulation of similar obstructions brought into the channel and chutes by freshets and fallen timber, from the caving and washing of the banks. Nothing has been expended on shore protection, and but a small proportion in contracting the stream to its normal width by jetties; this has been due to the small amount of the annual appropriations. However, in every instance where jetties have been constructed and remained in good condition, a depth of 6 feet has been secured at low water, and the channel very much straightened.

The general width of the Alabama River ranges from 500 to 600 feet, and wherever this width is exceeded the bars, shoals, etc., are to be found. In the open reaches, often many miles in length, the depth at low water ranges from 8 to 25 feet; the rate of inclination is nearly uniform and the fall at the bars is not materially increased over the average, which is about 4 inches per mile; the current nowhere exceeds 1½ miles per hour in the reaches, and no excessive velocity is to be found in any of the chutes except at and below the junction of the Coosa and Tallapoosa rivers, where the velocity reaches the maximum of about 3.1 miles per hour, and the distance between the bars, etc., ranging from one-half to 12 miles, with an abundant volume of water at all seasons; the improvement, therefore, at each locality will be comparatively independent and will have but little effect upon those above or below. The great similarity in the general characteristics of all the obstructions admits the adoption of a uniform method of improvement along the entire river, and plans and estimates can be safely submitted to carry it out on any scale that may be contemplated, or any future development of commerce may justify.

The estimate herein submitted is for maintaining the improvement by the removal of logs, snags, and other obstructions from the channel, also overhanging trees from the banks where they interfere with navigation; to protect rapidly caving banks; to construct works of contractions where needed; to increase the depth at low water to 6 feet; to excavate rock reefs and bars, where the material is such as will not scour to conform to the improved channel, and finally to carry out in connection with this work a detailed survey of the bars, shoals, islands, etc., wherever necessary.

Estimate of cost of improving the Coosa and Alabama rivers from Wetumpka on the former to the mouth of the latter, an estimated distance of 322 miles:

Estimated cost of works of contraction and shore protection	$305,871
Estimated cost of snagging operations	30,000
Estimated cost of surveys, supervision of work, contingencies, etc., 15 per cent	50,380
Estimated total cost	386,251

The Coosa and Alabama rivers, upon completion of the improvements now in course of construction, will have a total navigation length as follows:

	Miles.
Oostenaula and Coosawattee rivers, Georgia, to Rome, Ga	105
Coosa River, Georgia and Alabama, from Rome, Ga., to the junction with the Tallapoosa River	315
Alabama River, Alabama, from the junction of the Coosa and Tallapoosa rivers to the junction with the Tombigbee River, forming Mobile River	312
Mobile River to Mobile, Ala., at head of Mobile Bay	44
Mobile Bay to Gulf of Mexico	36
Total	812
Tallapoosa River, Alabama, from Tallassee, Ala., to junction with the Coosa River	48
Cahawba River, Alabama, from Centreville, Ala., to junction with the Alabama River	88
Total navigable mileage	948

This river system drains one of the most fertile sections in agricultural products and the wealthiest in valuable timber, building stones and marbles, coal fields, and

Digitized by Google

iron deposits in the South, and all the commerce that may be developed in this section by the improvement now in progress on these rivers, and which may seek the coast or foreign markets by water, must be transported on the Alabama River. This large additional business, independent of the coal and iron shipments from the Coosa and Cahawba and the log and timber rafts from all four, added to that at present on the Alabama, will require steamers of greater capacity and draft than are now in this trade, thereby necessitating a greater depth at low water. The business on the Alabama has more than doubled since 1884. The amount reported for that year was $4,438,732; the most conservative estimate of the total value of that of the year ending September 1, 1890, places it in round numbers at $10,000,000. The nature of this business has changed in this respect, that a much larger proportion of it is now done in the upper river between Selma and Montgomery than in previous years.

The accompanying tabular statement of the condition of the Alabama River October 1, 1890, was compiled from information obtained from the report of Mr. G. B. Yuille of the survey made in 1875, from pilots and steamboatmen and from observations and surveys made by me during the past year. The width of the channel, as given in the last column of the statement, is for the most part an approximate estimate. Nine of the most important and serious obstructions, however, are from accurate detailed surveys made during 1889, and are as follows; Hadnot Bar, Gardner Island, Yellow Jacket, Hobbs Island, Stein Island, Haines Island, Carter Shoals, Aberdeen Wrecks, and the Cut-Off.

Statement of the condition of the channel of the Alabama River at the various bars, islands, and shoals from the junction of the Coosa and Tallapoosa rivers to the mouth of the Alabama River, October 1, 1890.

Distance from Montgomery.	Name.	Condition of channel.	Nature of bottom.	Minimum depth at low water.	Minimum width of channel at low water (estimated).
Miles				*Feet.*	*Feet.*
17½	Tallapoosa Bar	Has materially changed since survey of 1875.	Gravel	Unknown.	Unknown.
17	Big Bend Bar	....do	Rock	....do	....do
14½	Glenn Chute	Fair run; straighter than in 1875, the bar having washed away to some extent.	Rock and gravel	6	100
13	Coosada Island	Channel fair, but full of logs, removal of which is all that is needed at this point.	Gravel	6	100
11½	Gun Chute	Snags, logs, and leaning timber, if taken out will do.	....do	6	100
10½	Rock Shoals	Is crooked and runs in bad shape around lower end of bar.	Rock and gravel	4½	75
6½	Lexington Bar	Fair, but narrow channel	Gravel	4½	60
1½	Bar above Montgomery	Good	....do	6	150
0	Montgomery				
2	Upper of Three Chutes*	Channel across river	Gravel and sand	4½	60
	Middle of Three Chutes	Channel fair	....do	6	60
	Lower of Three Chutes	Channel fair, but close	....do	4½	60
3	Gause Upper Bar	....do	....do	4½	60
4	Gause Lower Bar	Channel crooked	....do	6	70
6½	The Rocks	Channel good	Rock	6	125
7½	Duncan Bar	Channel crooked	Gravel	4½	125
8½	Reese Bar	Channel good	....do	6	125
11½	Cox Bar	Channel fair, depth increased this year.	....do	5	130
13	Washington Bar	Channel fair	Rock and gravel	4½	140
14	Hadnot Bar*	Channel fair, but very narrow.	Gravel	4	50
15	Catoma Bar	Channel across river	....do	4½	100
18	Possum Bight	Channel good	....do	6	150
18½	Manack Island	Channel fair	....do	4½	75
19	Turnipseed Bar	....do	....do	5	80
21	Tallawassee Creek Bar	Channel good	....do	6	100
21½	Tallawassee Bar	....do	Rock in bottom	4½	75
25½	Huffman Bar	....do	Gravel	6	100
28	Newport Bar	....do	Rock and gravel	6	100
29	Tight Eye, or Alexander.	Channel good, but close	Gravel	6	50

* Contraction works have been constructed, but are now more or less destroyed.

Digitized by Google

Statement of the condition of the channel of the Alabama River, etc.—Continued.

Distance from Montgomery.	Name.	Condition of channel.	Nature of bottom.	Minimum depth at low water	Minimum width of channel at low water (estimated).
Miles				*Feet.*	*Feet.*
30	Nunn Bar	Channel good	Gravel	6	100
31½	Swift Creek Bar	....do	....do	6	100
32½	Golson Bar	Channel good, but close	....do	6	60
33½	Dutch Island	....do	....do	6	60
36	Cypress Creek Bar	....do	....do	5	65
37	Indian Holy Ground Bar.	....do	Gravel and rock at foot.	4½	70
39	Gordon Bar	....do	Gravel, with some rock.	6	75
40	Edward Bar	....do	Gravel and rock	4½	75
42½	House Bluff Bar	....do	Gravel	5	75
43	Edwards Shoals	....do	....do	4½	75
45	Tyus Bar	Channel divided and bad	....do	4	50
46½	Haroldson Bar	Channel good	....do	6	70
48	Gresham Bar	....do	Gravel and rock	5	100
52½	Bar above Benton	Channel fair	Gravel	5½	100
53	Big Swamp Creek Bar.	Channel good	....do	6	100
54½	Bar below Benton	....do	....do	5	100
56½	Woods Bar	Channel fair	Soapstone	5	100
58½	Morgan (or Stewart) Bar.	Channel good	Gravel	5	100
58½	Hooper Bar	....do	....do	5	100
59	Giraffe Bar	....do	....do	5	60
60	Upper Brother Bar	....do	....do	6	75
60½	Lower Brother Bar	....do	....do	6	75
62½	Creek Shoals	....do	Gravel and rock	5	70
63½	Gaston Bar	Channel good, but bad for tows on account of rocks in bend.	Rock	5	50
64	Old-Hell Bar	Channel good	Gravel	5	60
65½	Gardner Island*	Channel crooked, narrow, variable, troublesome, and obstructed.	Gravel, rock, and dams.	4½	50
66½	Bar below Gardner Island.	Channel good	Gravel	6	100
69½	Mrs. Bat. Smith Bar	....do	Gravel and rock	5	100
71	Cunningham Bar	....do	Rock	5	100
72	Fish Trap Bar	Channel good, but very close.	Gravel with rock at foot of bar.	5	40
73	Soapstone Bar	Channel crooked and variable.	Rock	5	50
76½	Tarver Bar	Channel good	Gravel	5	100
78½	Kornegay Bar	Channel good, wreck at foot.	....do	5	100
79	Tipton Bar	Channel good	....do	5	60
79½	Second bar above Selma.	....do	....do	5	65
80½	First bar above Selma.	Channel good, but very close.	Gravel with rock above mouth of creek.	4½	50
81	Selma				
83	Valley Creek Bar	Channel good, but full of logs.	Gravel	5	75
83½	Tight Eye No. 1 Bar	Channel good, but close	Gravel with rock along shore.	6	40
86½	Cade Bar	Channel good	Gravel	6	100
89½	King Bend Bar	....do	....do	5	100
90½	Cloud Bar	Channel good, loggy	....do	5	60
95	Watt Bar	Channel good	....do	6	60
100	Matthew Bar	....do	....do	6	100
102	King Bar	Channel good, but close	....do	4½	50
103	Turkey Ford Bar	Channel good, variable in depth.	Gravel and rock	5	60
105½	Mitchell Bar	Channel good	Gravel	6	70
106	Mary Taylor Bar	Channel good, but very close, with sunken coal barge at head.	....do	4½	40
107½	Whites Bluff Bar	Channel good	Gravel and rock bowlders.	6	40
110½	Rifleman Bar	....do	Gravel	5	50
113	Upper Sister Bar	....do	....do	6	75
114	Middle Sister Bar	....do	....do	4½	70
115	Lower Sister Bar	Channel good but very close.	....do	4½	40
118	Providence Bar	Channel good	....do	5	70

* Contraction works have been constructed and still remain in fair condition.

Digitized by Google

Statement of the condition of the channel of the Alabama River, etc.—Continued.

Distance from Montgomery.	Name.	Condition of channel.	Nature of bottom.	Maximum depth at low water.	Minimum width of channel at low water (estimated).
Miles.				*Feet.*	*Feet.*
119½	Portland Upper Bar	Channel good, but very close.	Gravel	4	60
123¼	Portland Lower Bar	do	do	4	50
126½	Lexington Bar	Channel good	Soapstone	5	70
132½	Hurricane Bluff Bar	do	Gravel	5	40
134¼	St. John Bar	do	do	5	70
140¼	Canton Upper Bar	Channel good, but loggy	do	5	60
143½	Canton Lower Bar	Channel good, but loggy and close.	do	4	40
144½	Young Bar	Channel good	do	5	60
148½	Mixon Bar	do	do	5	40
149	McGuire Bar	Channel good, but close	do	4	60
149¾	Bar above Prairie Bluff.	Channel good	Gravel with rock at foot.	6	60
151¼	Miller Ferry Bar	Channel good, but close	Gravel	4½	50
152½	Prairie Bluff Shoals	Channel good	do	6	100
163	Evans Upper Bar	Channel good, but close	do	5	70
166	Evans Lower Bar	Channel good	do	6	100
169	Yellow Jacket Bar*	do	do	6	75
169½	Hobb Island*	do	do	5	100
173½	Pursley Creek Shoals	do	Rock	5	100
174½	Blacks Bluff Bar	do	do	5	100
176	Tait Bar	do	Gravel	5	60
177½	Wilcox Bar	do	Gravel with rock at lower end.	6	60
179½	McNeil Bar	Channel good, with wrecks at head of bar and in way of tow.	Shelving rock	6	60
185½	Montgomery Bar	Channel good	Gravel	6	180
189½	Ohio Bar	do	do	6	100
191½	Stein Island	Channel good, but close	do	4½	60
198	Bates Bar	Channel good	do	6	125
203	Haines Island†	Channel very crooked	Gravel with rock at Legget and Cobb Landing.	4	110
208	Stabler Woodyard Rock.	A small pile of rock in center of river, good depth around it.	Rock	6	150
210	Silver Creek Shoals	Channel good	Rock at foot	5	75
225½	Pigeon Creek Bar	do	Gravel	6	100
227	Mrs. Gray Bar	do	do	6	100
234½	Flynn Bar	do	do	6	100
236½	Shackleford Bar.	do	do	6	70
240½	Jewett Bar	do	Gravel and sand	6	70
243	Carter Shoals	do	do	6	70
244	Erwin Bar	do	do	6	100
247	Williamson Bar	do	do	5	50
252	Choctaw Bar	do	do	6	100
254½	Matthewson Bar	do	do	6	70
258	Tait Shoals	Channel good, wreck at head of shoals.	do	6	75
264	Earle Bar	Channel good	do	6	100
265½	Wrecks of the Aberdeen, etc.	do	do	5	100
276½	Cut-off Bar*	do	do	4	75
277½ to 293½	Old Cut-off Bar	do	do	6	200
	Mouth of the Alabama River	do		6 to 30	500

* Contraction works have been constructed and still remain in fair condition.
† Contraction works have been constructed, but are now more or less destroyed.

Respectfully submitted.

C. B. PERCY,
Assistant Engineer.

Capt. P. M. PRICE,
Corps of Engineers, U. S. A.

Digitized by Google

APPENDIX Q.

IMPROVEMENT OF CERTAIN RIVERS IN ALABAMA AND MISSISSIPPI, OF BOGUE CHITTO, LOUISIANA, AND OF HARBORS AT MOBILE, ALABAMA, AND BILOXI, MISSISSIPPI.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mobile Harbor, Alabama.
2. Warrior and Tombigbee rivers, Alabama and Mississippi.
3. Black Warrior River, Alabama, from Tuscaloosa to Daniels Creek.
4. Noxubee River, Mississippi.
5. Pascagoula River, Mississippi.
6. Chickasahay River, Mississippi.
7. Bluff Creek, Mississippi.
8. Leaf River, Mississippi.
9. Harbor at Biloxi Bay, Mississippi.
10. Pearl River, Mississippi, below Jackson.
11. Pearl River, Mississippi, between Jackson and Carthage.
12. Pearl River, Mississippi, between Edinburg and Carthage.
13. Bogue Chitto, Louisiana.

EXAMINATION.

14. Sucarnochee River, Alabama, from its mouth to the Mobile and Ohio Railroad Bridge.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., July 20, 1891.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year ending June 30, 1891, for the works under my charge.

Very respectfully, your obedient servant,

A. N. DAMRELL,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q 1.

IMPROVEMENT OF HARBOR AT MOBILE, ALABAMA.

The improvement of the channel of the harbor at Mobile, Ala., was begun by the General Government in 1827, the depth of water then being 5½ feet through Choctaw Pass and 8 feet on Dog River Bar.

Digitized by Google

The following appropriations were made:

By act of Congress—	
May 20, 1826	$10,000.00
March 2, 1829	20,000.00
June 24, 1834	10,000.00
March 3, 1835	17,997.60
March 3, 1837	50,000.00
July 7, 1838	50,000.00
August 3, 1852	50,000.00
	207,997.60
By act of Congress March 3, 1857 (relief claim)	20,833.08
Total	228,830.68

The result obtained was a channel 10 feet deep and 200 feet wide through the pass, and the same depth, with an unknown width, over the bar. In 1860 the channel through the pass was found to have shoaled to 7½ feet, the depth of water on the bar remaining the same. No further improvement was attempted until 1870.

From 1870 to 1875 the following amounts were appropriated for the purpose of obtaining a depth of 13 feet:

By act of Congress—	
July 11, 1870	$50,000
March 3, 1871	50,000
June 10, 1872	75,000
March 3, 1873	100,000
June 23, 1874	100,000
March 3, 1875	26,000
Total	401,000

This amount was expended in dredging a channel 13 feet deep and 300 feet wide from the mouth of the Mobile River through Choctaw Pass, and 13 feet deep and 200 feet wide through Dog River Bar to the 13-foot curve in the bay. The work was completed in 1876 and the channel remained practically as it was dredged until operations were commenced under a new project to obtain a depth of 17 feet. In 1878 a survey was directed to be made in order to determine whether the existing channel could be improved to a depth of 22 feet, and for this purpose Congress, by act of June 18, 1878, appropriated the sum of $10,000.

The survey was made and a report was submitted to the Chief of Engineers, suggesting several plans of improvement. In March, 1880, it was decided to continue the former improvement by dredging to a depth of 17 feet, with a uniform width of 200 feet, from the 17-foot curve in Mobile River to the curve of the same depth in the lower bay, the estimated cost being $820,000. From 1878 to June 30, 1887, the following amounts were appropriated:

By act of Congress—	
June 18, 1878 (survey)	$10,000
March 3, 1879	100,000
June 14, 1880	125,000
March 3, 1881	100,000
August 2, 1882	125,000
July 5, 1884	200,000
August 6, 1886	90,000
Total	750,000

Digitized by Google

Statement of work done under the above appropriations.

Date of act.	Name of contractor.	Contract price, measured in scow.	Cubic yards removed.	Commenced.	Completed.
		Cents.			
Mar. 13, 1879 June 14, 1880	George C. Fobes & Co	12.3	1,610.804	Feb. 19, 1881	Nov. 9, 1882
Mar. 3, 1881	G. L. Long	11.7	724,730	Mar. 21, 1882	Jan. 24, 1884
Aug. 2, 1882	R. Moore	12.3	888,093	Jan. 24, 1883	Feb. 9, 1884
July 5, 1884	Tobias Burke	9.0	1,920,438	Sept. 19, 1884	June 15, 1886
Aug. 6, 1886	R. Moore	9.5	829,854	Oct. 2, 1886	Apr. 25, 1887
	Total		5,973,919		

The channel of 17-foot depth was opened to a width of 75 feet in 1882 and was widened to 180 feet in 1889, and practically completed.

During this time vessels have passed through with a maximum draft of 18 feet, but owing to a filling in the cut at the lower end the draft has been generally limited to 16 feet.

February 6, 1885, a project was submitted for the improvement of Mobile River and Harbor, with a view to securing 23 feet depth of water by enlarging and deepening by dredging the channel, which, since 1870, has been deepened in that manner, first from 9 to 13 feet, and then from 13 feet to 17 feet. The estimated cost of the 23-foot project, with extension made by act of September 19, 1890, is $2,043,800, made up as follows:

Completion of 17-foot channel (including removal of material filled in cut) upon which estimate for the 23-foot cut was based	$282,000
Dredging channel 280 feet wide on top of cut and central depth of 23 feet	1,500,000
Removing material that will fill in during progress of work on 23-foot channel (during 3 years)	198,000
Dredging channel in Mobile River up to Chickasabogue 280 feet wide and 23 feet deep	63,800
Total	2,043,800

To which must be added $60,000 per year after this fiscal year for removing material that will fill in during the progress of the work.

From August 11, 1888, to the end of this fiscal year the following appropriations have been made:

By act of Congress—	
August 11, 1888	$250,000
September 19, 1890	350,000
Total	600,000

Under the appropriation of $250,000, made by act of August, 1888, work was commenced in October, 1888, and continued to the middle of February, 1890, at which time a cut had been made 80 feet wide and from 19 to 20 feet deep from Mobile to where that depth practically existed in the lower bay.

Under the appropriation of $350,000, made by act of Congress of September 19, 1890, work was commenced on January 1, 1891, and continued to the end of the fiscal year.

Statement of work done under above appropriations.

Date of act.	Name of contractor.	Contract price, measured in scows.	Cubic yards removed.	Commenced.	Completed.	Plant.
		Cents.				
Aug. 11, 1888	Alabama Dredging and Jetty Company.	9	2,312,295	Oct. 15, 1888	Feb. 17, 1890	2 clam-shell dredges, 4 scows, 2 tugs.
Sept. 19, 1890	National Dredging Company.	8½	896,964	Jan. 1, 1891	.....	3 clam-shell dredges, 8 scows, and 4 tugs.

Digitized by Google

Tabular statement showing the channel as dredged and its condition June, 1891.

Locality.	Dredged 1881-1890.				Examinations.				
	From the initial point.	Length between clusters.	Width.	Central depth.	Cross section at—	Top width.	June, 1889. Maximum depth in cross section.	June, 1890. Maximum depth in cross section.	June, 1891. Maximum depth in cross section.
	Miles.	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*
Initial point at mouth of Mobile River or Chain Cluster No. 1.	.....	.....	145	19-20	Chain Cluster No. 1.	620	18.8	21.4	20.4
Chain Cluster No. 1 to Chain Cluster No. 2.	0.6	330	145	19-20	Chain Cluster No. 2.	530	20.1	21.6	19.3
Chain Cluster No. 2 to Upper Gap light stake.	0.45	2,080	145	18-19	Upper Gap light stake.	700	21.1	20.5	21.5
Upper Gap light stake to Cluster No. 2.	0.64	978	245	18-19	Cluster No. 2.....	700	22.6	21.9	21.6
Cluster No. 2 to Chain Cluster No. 3.	1.07	2,259	155	18-19	Chain Cluster No. 3.	700	21.1	20.4	23.0
Chain Cluster No. 3 to Lower Gap light stake.	1.48	2,182	155	18-19	Lower Gap light stake.	700	19.9	20.3	20.0
Lower Gap light stake to Cluster No. 3.	1.96	2,565	145	19-21	Cluster No. 3.....	700+	22.4	22.2	20.5
Cluster No. 3 to Cluster No. 4..	2.46	2,603	145	23-24	Cluster No. 4.....	700+	20.3	20.2	26.2
Cluster No. 4 to Cluster No. 5..	3.25	4,194	145	23-24	Cluster No. 5.....	700+	22.8	20.6	28.0
Cluster No. 5 to Cluster No. 6..	3.50	1,338	145	23-24	Cluster No. 6.....	700+	22.6	20.8	26.5
Cluster No. 6 to Cluster No. 7..	4.02	2,735	145	23-24	Cluster No. 7.....	700+	21.3	18.8	23.5
Cluster No. 7 to Cluster No. 8..	4.59	2,998	145	23-24	Cluster No. 8.....	700+	21.9	19.6	26.7
Cluster No. 8 to Cluster No. 9..	5.09	2,654	145	19-21	Cluster No. 9.....	700+	22.3	20.2	28.0
Cluster No. 9 to Cluster No. 10.	5.61	2,713	145	19-21	Cluster No. 10.....	700+	21.7	20.8	18.6
Cluster No. 10 to Cluster No. 11.	6.11	2,655	145	19-21	Cluster No. 11.....	700+	20.4	19.0	18.4
Cluster No. 11 to Cluster No. 12.	6.60	2,610	145	19-21	Cluster No. 12.....	700+	20.2	19.0	17.8
Cluster No. 12 to Cluster No. 13.	7.08	2,501	145	19-21	Cluster No. 13.....	700+	21.6	19.3	18.2
Cluster No. 13 to Cluster No. 14.	7.54	2,418	145	19-21	Cluster No. 14.....	700+	21.4	19.4	18.1
Cluster No. 14 to Cluster No. 15.	8.03	2,625	145	19-21	Cluster No. 15.....	700+	21.1	19.3	18.2
Cluster No. 15 to Cluster No. 16.	8.54	2,666	145	19-21	Cluster No. 16.....	700+	20.6	19.3	17.9
Cluster No. 16 to Cluster No. 17.	9.03	2,591	145	19-21	Cluster No. 17.....	700+	21.8	19.2	17.6
Cluster No. 17 to Cluster No. 18.	9.52	2,582	145	19-21	Cluster No. 18.....	700+	20.4	19.1	17.8
Cluster No. 18 to Cluster No. 19.	10.01	2,616	145	19-21	Cluster No. 19.....	700+	21.3	19.0	17.9
Cluster No. 19 to Cluster No. 20.	10.52	2,659	145	19-21	Cluster No. 20.....	700+	16.8	19.7	18.0
Cluster No. 20 to Cluster No. 21.	11.00	2,580	145	19-21	Cluster No. 21.....	700+	16.5	20.5	18.2
Cluster No. 21 to Cluster No. 22.	11.41	2,550	145	19-21	Cluster No. 22.....	700+	15.9	19.6	17.8
Cluster No. 22 to Cluster No. 23.	11.99	2,590	145	19-21	Cluster No. 23.....	700+	18.0	19.2	17.8
Cluster No. 23 to Cluster No. 24.	12.45	2,502	145	19-21	Cluster No. 24.....	700+	17.9	19.5	17.2
Cluster No. 24 to Cluster No. 25.	12.94	2,560	145	19-21	Cluster No. 25.....	700+	17.6	19.2	17.4
Cluster No. 25 to Cluster No. 26.	13.42	2,535	145	19-21	Cluster No. 26.....	700+	17.2	18.7	17.1
Cluster No. 26 to Cluster No. 27.	13.91	2,592	145	19-21	Cluster No. 27.....	700+	15.7	18.2	17.2
Cluster No. 27 to Cluster No. 28.	14.40	2,592	145	19-21	Cluster No. 28.....	700+	15.5	18.4	17.0
Cluster No. 28 to Cluster No. 29.	14.99	2,587	145	19-21	Cluster No. 29.....	700+	15.6	17.9	17.1
Cluster No. 29 to Cluster No. 30.	15.39	2,620	145	19-21	Cluster No. 30.....	700+	15.8	18.3	16.7
Cluster No. 30 to Cluster No. 31.	15.91	1,790	145	19-21	Cluster No. 31.....	700+	16.0	17.2	16.1
Cluster No. 31 to Cluster No. 32.	16.21	2,580	145	19-21	Cluster No. 32.....	700+	18.5	17.7	16.3
Cluster No. 32 to Cluster No. 33.	16.71	2,650	185	19-21	Cluster No. 33.....	700+	19.8	17.4	16.4
Cluster No. 33 to Cluster No. 34.	17.24	2,750	185	19-21	Cluster No. 34.....	700+	19.3	16.7	16.0
Cluster No. 34 to Cluster No. 35.	17.75	2,725	185	19-21	Cluster No. 35.....	700+	18.6	17.3	20.1
Cluster No. 35 to Cluster No. 36.	18.27	2,750	185	23-24	Cluster No. 36.....	700+	19.3	16.6	23.7
Cluster No. 36 to Cluster No. 37.	18.77	2,615	185	23-24	Cluster No. 37.....	700+	18.5	15.9	24.5
Cluster No. 37 to Cluster No. 38.	19.25	2,540	185	23-24	Cluster No. 38.....	700+	18.9	16.5	23.2
Cluster No. 38 to Cluster No. 39.	19.76	2,695	185	23-24	Cluster No. 39.....	700+	18.9	16.6	23.3
Cluster No. 39 to Cluster No. 40.	20.27	2,705	185	23-24	Cluster No. 40.....	700+	18.4	15.9	23.2
Cluster No. 40 to Cluster No. 41.	20.69	2,227	185	23-24	Cluster No. 41.....	700+	19.8	16.2	22.7
Cluster No. 41 to Cluster No. 42.	21.29	3,160	185	19-21	Cluster No. 42.....	700+	19.0	15.8	19.7
Cluster No. 42 to Cluster No. 43.	21.83	2,824	185	19-21	Cluster No. 43.....	700+	18.6	15.6	14.7
Cluster No. 43 to Cluster No. 44.	22.33	2,660	185	19-21	Cluster No. 44.....	700+	20.7	16.7	14.9
Cluster No. 44 to Cluster No. 45.	22.94	3,230	185	19-21	Cluster No. 45.....	700+	17.8	17.8	15.4
Cluster No. 45 to Cluster No. 46.	23.35	2,145	185	19-21	Cluster No. 46.....	700+	16.5	17.5	15.4
Cluster No. 46 to Cluster No. 47.	23.89	2,865	185	19-21	Cluster No. 47.....	700+	16.2	17.9	16.1
Cluster No. 47 to Cluster No. 48.	24.40	2,701	185	19-21	Cluster No. 48.....	700+	17.0	18.3	16.1
Cluster No. 48 to Cluster No. 49.	24.94	2,833	185	19-21	Cluster No. 49.....	700+	17.0	19.5	17.0
Cluster No. 49 to Cluster No. 50.	25.49	2,930	185	19-21	Cluster No. 50.....	700+	17.7	20.4	17.7
Cluster No. 50 to Cluster No. 51.	25.91	2,210	185	19-21	Cluster No. 51.....	700+	18.6	18.6	17.8

Five hundred thousand dollars annually is the least amount that can be used in a successful prosecution of the work.

Digitized by Google

Money statement.

July 1890, balance unexpended		$2,508.25
Amount appropriated by act approved September 19, 1890		350,000.00
		352,508.25
June 30, 1891, amount expended during fiscal year		59,188.57
July 1, 1891, balance unexpended		293,319.68
July 1, 1891, outstanding liabilities	$27,829.30	
July 1, 1891, amount covered by uncompleted contracts	244,889.32	
		272,718.62
July 1, 1891, balance available		20,601.06
Amount (estimated) required for completion of existing project		1,443,800.00
Amount (estimated) required for preservation of improvement		60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893		1,503,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for improving Mobile Harbor, Alabama, received and opened November 20, 1890, by Maj. A. N. Damrell, Corps of Engineers.

[Time of commencing and completing work in accordance with specifications.]

No.	Name and address of bidder.	Price per cubic yard of dredging sand.	Price per cubic yard of dredging clay.
		Cents.	*Cents.*
1	Anglo-Southern Construction Company, New York, N. Y.	16	12
2	M. J. Fauria, Pensacola, Fla	40	9 1/2
3	Moore & Wright, Portland, Maine	18	11
4	National Dredging Company, Wilmington, Del	.....	8 3/4
5	Alabama Dredging and Jetty Co., Mobile, Ala	19	9
6	George C. Fobes & Co., Baltimore, Md.	19	9

COMMERCIAL STATISTICS.

Description.	Entrances to—						Clearances to—					
	June 30, 1891.			June 30, 1890.			June 30, 1891.			June 30, 1890.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Foreign	137	87,781	1,778	144	98,382	1,967	149	100,001	1,772	251	107,078	2,171
Coastwise	130	78,187	2,184	82	50,819	1,509	71	37,955	895	66	34,649	660
American	45	15,601	331	81	29,056	610	60	21,071	481	69	19,235	497
Total	312	181,569	4,293	307	178,257	4,086	280	159,027	3,148	386	160,962	3,328

Imports and exports.

	1891.	1890.
Duties on imports	7,560.67	5,556.74
Tonnage dues	4,945.50	6,317.69
Hospital collections	552.50	267.00
Miscellaneous	1,255.60	221.43
Total collections	14,314.27	12,362.86
Exports to foreign ports	3,309,308.00	3,371,298.00
Imports:		
Free	73,883.00	90,169.00
Dutiable	13,308.00	6,654.00

Digitized by Google

Comparative statement of timber, lumber, etc., shipped to foreign and coastwise ports.

Description.	1891.	1890.	1889.	188[illegible]
Lumber:	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Foreign	40,054	87,364	28,278	15[illegible]
Coastwise	31,123	11,792	34,214	12[illegible]
Total	71,177	99,156	62,492	28[illegible]
Timber:				
Foreign	62,292	33,992	39,182	27,101
Coastwise	.....	.....	1,144	1,744
Total	62,292	33,992	40,326	28,845
Shingles:				
Foreign	129	135	90	866
Coastwise	19	154	24	480
Total	148	289	114	1,346
Staves:				
Foreign	111	504	2,588	831
Coastwise	83	.....	392	.....
Total	194	504	2,980	831

The following is a comparative statement of the number and character of vessels of greater draft than 13 feet which have passed through the dredged channel without any material detention during the fiscal years ending June 30, 1890 and 1891:

Draft in feet.	Steamships.				Ships.				Barks.				Brigs.				Schooners and barges.				Total.			
	Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.		Up.		Down.	
	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.	1890.	1891.
13 to 14	16	5	5	7	4	4	...	...	16	18	1	...	1	...	2	...	2	31	9	36	30	37	18	
14 to 15	3	3	5	53	3	2	...	...	14	16	2	2	...	1	1	3	3	29	21	23	24	37	77	
15 to 16	...	...	21	3	1	1	...	1	2	6	10	7	...	2	4	3	4	28	22	6	11	61	33	
16 to 17	1	...	14	10	...	...	10	7	1	1	88	66	...	3	1	...	3	16	14	2	4	131	98	
17 to 17½	...	...	3	6	...	...	...	...	...	2	9	3	...	...	1	...	...	4	3	...	2	16	13	
17½ to 18	...	...	...	1	...	...	...	...	...	...	...	2	...	...	...	...	...	4	...	...	...	4	3	
Total	20	8	48	80	8	7	10	8	33	43	110	80	1	6	9	6	12	112	69	67	71	286	246	

NOTE.—The apparent discrepancy in the numbers of vessels arriving and departing is explained by the fact that many craft come up the channel drawing less and go down drawing more than 13 feet.

Q 2.

IMPROVEMENT OF WARRIOR AND TOMBIGBEE RIVERS, ALABAMA AND MISSISSIPPI.

WARRIOR RIVER.

The examination and partial survey of the river from Tuscaloosa to Demopolis was made in 1874, and report thereon may be found in the report of the Chief of Engineers of 1875, Part II, page 16.

In its original condition the river was well adapted for high-water navigation, having a width of 400 feet at Tuscaloosa, gradually diminishing to 150 feet near its mouth. The boating stage usually lasted 5

Digitized by Google

months, from December 1 to May 1, the depth ranging from 10 to 40 feet, and the only obstructions encountered were overhanging trees, which sometimes carried away the chimneys of steamboats and damaged their upper works. Below a 10-foot stage snags became troublesome, and below 5 feet navigation practically ceased.

The obstructions to low-water navigation were:

(1) Ninety-four bars and reefs that afforded a ruling depth of 12 to 30 inches.

(2) Numerous snags and sunken logs, chocking up the bar chutes, and frequent in the reaches also.

(3) Overhanging trees, that effectually closed narrow chutes even if otherwise open.

The improvement of the Warrior was authorized by act of Congress of March 3, 1875, and the project adopted was to deepen the bars by jetty construction, remove snags and cut down overhanging trees, with a view to obtaining for small boats a low-water channel 80 feet wide by 4 in depth.

The estimated cost of the improvement was $151,103. Appropriations have been made as follows:

Warrior and Tombigbee rivers:	
March 3, 1875	$25,000
August 14, 1876	15,000
June 18, 1878	28,000
March 3, 1879	20,000
Warrior River:	
June 14, 1880	20,000
March 3, 1881	10,622
August 2, 1882	10,000
July 5, 1884	12,000
August 5, 1886	18,750
August 11, 1888	18,000
September 19, 1890	45,000
Total	222,372

Of this amount $134,372 was appropriated for the Warrior, and $88,000 for Warrior and Tombigbee jointly. The execution of the project was commenced in June, 1875, and has been continued for an average annual period of 4 months up to November 10, 1885, and for 3 months in 1887, the work being confined chiefly to the removal of snags and overhanging trees. Channel deepening by jetty construction was also attempted upon 49 of the bars affording the shoalest water. The work in 1887 was done by contract. The work of removing snags and logs has been repeated several times over a great part of the river. This has been made necessary from the fact that land slides and caving banks every year throw many trees into the river that, anchored by their roots, obstruct the channel. This trouble will continue until stability shall have been given to the yielding banks. The work of sloping and revetting needed for this purpose was not originally contemplated, but as the necessity for it became apparent an experimental section 3,000 feet long was tried in 1886, costing at the rate of $6,000 per mile. This has proved satisfactory.

The practical results thus far accomplished may be stated as having lowered the navigable stage 3 feet; a boat with 600 bales of cotton and drawing 4½ feet passed down the river without difficulty on a stage barely 2 feet above low water.

Better results than this could not be expected in continuing the old project, because the slope on portions of the river is such that the low-water discharge will not give a uniform depth of more than 2½ feet in

Digitized by Google

a channel of 80 feet width. Moreover, the statement as to the results obtained holds good only in the fall, because the low-water chutes around the bars lie out the current during high water, and consequently fill up. The scouring-out process does not keep pace with the fall of the river surface in the spring, and it is not until late in the summer that the chutes become fully opened.

From the above it is evident that, to secure a 4-foot low-water channel of navigable width, a different project from the one heretofore worked under had to be adopted, and when the improvement of the Black Warrior River above Tuscaloosa was undertaken for the benefit of the recently developed mineral business of the Upper Warrior, it was evident that the 6-foot low-water depth adopted in that project should be extended throughout the river below.

These facts being recognized, a survey of the Warrior was authorized from Tuscaloosa to the mouth, in order to get the data necessary for preparing plans and estimates for the improvement of the river on scale desired.

This survey was commenced in the summer of 1887 and completed in the fall of 1889, and a report was submitted December 24, 1889, proposing a plan of improvement to obtain a good channel with a minimum depth of 6 feet at low water by a system of dams and pneumatic gates in connection with snagging, cutting of overhanging trees, bank revetment, and bar improvement at an estimated cost of $577,000.

Since that time a more careful study of the data obtained by the survey has resulted in a change in the views previously entertained, and a belief that locks similar in size and general construction to those above Tuscaloosa will be better than the pneumatic gates.

The work on the river during the fiscal year was confined to the preparation of a portion of a suitable plant for future use in the improvement of the river, the old plant having been completely used up and an attempt to do the work by contract having resulted in the conviction that it was more economical and advantageous to do the work by day's labor. This plant is now nearly ready, and work will be soon commenced by removing snags, logs, and overhanging trees.

Money statement.

July 1, 1890, balance unexpended	$13,967.98
Amount appropriated by act approved September 19, 1890	45,000.00
	58,967.98
June 30, 1891, amount expended during fiscal year	21,840.85
July 1, 1891, balance unexpended	37,127.13
Amount (estimated) required for completion of existing project	532,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1891.	1890.
	Tons.	*Tons.*
Cotton	1,500	3,364
Grain	685	285
Iron	21	17
Lumber	5	
General merchandise	1,815	1,011
Total	4,026	4,677

Digitized by Google

TOMBIGBEE RIVER FROM WALKER'S BRIDGE TO FULTON.

The examination of this section of the Tombigbee River was provided for by the river and harbor act of March 3, 1881, and again by the river and harbor act of August 5, 1886. An examination was made under the first act, and a report was submitted February 10, 1882, which is contained in the Annual Report of the Chief of Engineers for 1882.

Under the second act reference was made to the examination previously made.

For the improvement of this section of the river the

River and harbor act of—	
August 11, 1888, appropriated	$4,000
September 19, 1890, appropriated	4,000
Total	8,000

The projected improvement was the opening of a channel for high-water navigation from Fulton up to Walker's Bridge by the removal of snags and overhanging trees, at an estimated cost of $11,000. Work was commenced at Fulton on November 17, 1888, and continued to December 21, 1888, when work was suspended on account of high water. It was resumed as soon as the stage of water would permit, March 15, 1889, and continued to the middle of August, 1889. Work under appropriation of $4,000, made by act of September 19, 1890, was commenced in January, 1891, at Stevens Field and carried on until a rise of the river caused suspension on February 4, 1891, and resumed again in March, and Walker's Bridge was reached in May 16, 1891. On account of high water during March, April, and May, 1891, considerable necessary work had to be passed over; it was deemed best to return downstream and go over the work again while the water was low. The party working down stream reached Fulton on the 30th of June, 1891, and completed the projected improvement. The improvement made will not be permanent, but, owing to caving of banks and shifting of channels, will require reworking from time to time.

The following obstructions were removed during the fiscal year ending June 30, 1891:

Trees pulled	454
Trees cut	2,886
Logs removed	1,085
Drifts removed	4
Stumps removed	640

The results obtained by the improvement are as follows: Rafts of timber of much larger size than formerly can be floated down without breaking them up, as was formerly necessary, on a stage of water 3½ feet above low water, and barges 80 feet long, 22 feet beam, and 4 feet draft can be used when the water is 5 feet above low water.

It is estimated that the saving in freight and expense of transportation on cotton and timber and other supplies will be not less than $12,000 annually.

The length of this section of the river as given in the report of the preliminary examination (25 miles) is much too small.

Money statement.

July 1, 1890, balance unexpended	$265.30
Amount appropriated by act approved September 19, 1890	4,000.00
	4,265.30
June 30, 1891, amount expended during fiscal year	2,782.48
July 1, 1891, balance unexpended	1,482.82

Digitized by Google

Amount (estimated) required for completion of existing project	$3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	3,000.00
Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Articles.	1891.	1892.
	Tons.	*Tons.*
Pine, cypress, and poplar timber	3,000	2,626
White-oak pipe-staves	125	.....
Total	3,125	2,626

TOMBIGBEE RIVER, FROM FULTON TO VIENNA.

A survey of that portion of this section of the river from Fulton down to Columbus, 144 miles, was made under the act of June 10, 1872, and report of same submitted September 20, 1873. This report is contained in the Annual Report of the Chief of Engineers for 1873.

An examination was made of the remaining portion, 65 miles, under the act of July, 1870, report upon which is contained in Annual Report of the Chief of Engineers for 1871.

Previous to improvement navigation was carried on only during the winter (high water) season and was seldom attempted above Aberdeen, 112 miles below Fulton. Snags, sawyers, and stumps obstructed the channel in low stages, so that navigation practically ceased on a stage 6 feet above low water below Columbus, and 12 feet above. Overhanging trees were troublesome at all stages and frequent cause of damage. The normal width of the river on a navigable stage was from 80 feet at Fulton to 150 at Vienna. The project adopted for this division was to improve high-water navigation from Fulton to Columbus by removing all timber obstructions above the low-water plane and to clear the banks of overhanging trees. From Columbus to Vienna, besides clearing the river bed and banks of obstructions, it was proposed to deepen the bars by dikes and jetties so as to increase the depth of them (12 inches to 13 inches) to 3 feet, with a width of 40 feet.

The estimated cost of the improvement of the entire river was $205,000.

The amounts appropriated for this division, and specially designated in appropriations made for the Warrior and Tombigbee have been:

By act of—		By act of—	
March 3, 1873	$10,000	August 2, 1882	$7,500
June 18, 1878	12,000	July 5, 1884	10,000
March 3, 1879	10,000	August 5, 1886	7,500
June 14, 1880	16,000	August 11, 1888	6,500
March 3, 1881	7,365	September 19, 1890	6,000

Work was commenced in August, 1887, and continued annually during a portion of each year until May 12, 1888. The work accomplished has been as follows: From Fulton to Columbus the project has been completed as designated and navigation secured down to a stage 4 feet above low water, but needs working over again. Below Columbus 5,130 snags, stumps, and sunken logs have been removed, overhanging trees cut, and 20 bars deepened to 3 feet, leaving 15 unimproved. This section also needs working over again. The effect of the improvement has been to afford a navigable channel from Columbus to Vienna

Digitized by Google

for boats drawing 3 feet with the river 2 feet above low water. Another foot can be gained by improving the unworked bars on the plan heretofore adopted, but the results obtained from the deepened bars show that they will not generally maintain the 3 feet required, and a 2-foot low-water channel is all that can be expected from the scouring method heretofore used.

The cost of maintaining the improved condition would be about $8,000 annually.

A survey of the river from Columbus to Vienna was made in 1887, and report with project and estimates for a channel of 6 feet depth at low water was submitted December 24, 1889.

Work during the year has been the preparation of part of a plant for future operations and the commencement of work of improvement at Fulton June 30, and at Aberdeen June 15, 1891, both forces working down, and at Vienna June 28, 1891, this force working up towards Columbus.

Work on this section of the river has been completed according to project, and appropriations hereafter will be for preservation of improvement.

This section of the river hereafter should be designated from Fulton to Columbus.

Money statement.

July 1, 1890, balance unexpended	$3,975.49
Amount appropriated by act approved September 19, 1890	6,000.00
	9,975.49
June 30, 1891, amount expended during fiscal year	5,261.23
July 1, 1891, balance unexpended	4,714.26
Amount (estimated) required for preservation of improvement	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR 1891.

	Tons.
Cotton	413
Cotton seed	1,214
Fertilizer	235
Grain	277
Meat	75
Flour	71
General merchandise	111
Total	2,396

TOMBIGBEE RIVER, BELOW VIENNA.

An examination of this portion of the river, 275 miles, was made under the act of July 11, 1870, report upon which is contained in Annual Report of the Chief of Engineers for 1871.

From Vienna to Demopolis, 91 miles, the original condition of the river for navigation purposes was similar to that already described as that existing between Vienna and Columbus, and the same project for improvement was adopted. The width ranged from 150 to 200 feet.

Below Demopolis the river, with discharge from the Warrior added,

Digitized by Google

increased in width to 300 feet, and below Coffeeville to 500 feet, but with little gain in depth on the bars. In fact, low-water navigation could be relied on only as high up as Bladen, 143 miles from Mobile.

Snags were very numerous, and at some points could be passed through only in daylight. The project adopted was to clear the river of snags and secure a 4-foot channel of navigable width through the bars by jetty construction. The estimated cost for the entire river (including upper division) was $205,000.

Appropriations have been made as follows:

Warrior and Tombigbee—	
March 3, 1875	$25,000
August 14, 1876	15,000
June 18, 1878	28,000
March 3, 1879	20,000
Tombigbee River, below Vienna—	
June 14, 1880	15,000
March 3, 1881	8,013
August 2, 1882	12,500
July 5, 1884	15,000
August 5, 1886	11,250
August 11, 1888	6,000

Work was commenced in 1873, and has continued annually for an average period of five months up to October 20, 1885, and for six weeks in 1887.

The work accomplished has been in the main the removal of snags and leaning timber; 5,232 snags have been taken out and trees cut away. Much of this work has been done in the annual revision made necessary by obstructions caused by caving banks. Fifteen bars above Demopolis have also been deepened to a depth of 2½ to 3 feet, and six below to a depth of 3½ to 4 feet.

The improvement thus far made has afforded safe navigation to Demopolis at low water for boats drawing 2½ feet and to Kirkpatricks, 267 miles from Mobile, for boats of 2 feet draft. Beyond this a rise of 2 feet is needed to carry boats of 3 feet draft to Vienna. The depths gained upon the improved bars are well maintained, but the channels are narrow and crooked, so that the full depth is not available. Below Bladon three bars have formed of late years that do not afford more than 2½ feet at low water.

The necessity of a deeper channel than that originally contemplated applies to this river for the same reason as that given in the report for the Warrior. To obtain the data needed for preparing plans and estimates for this deeper channel, a survey was commenced in 1887 and completed in winter of 1889 and report submitted December 24, 1889.

During the past fiscal year operations have been, preparation of a part of a plant required for future work. This section of the river has been divided by the act of September 19, 1890, and will therefore be hereafter omitted.

Money statement.

July 1, 1890, balance unexpended	$265.36
June 30, 1891, amount expended during fiscal year	257.98
July 1, 1891, balance unexpended	11.38

Digitized by Google

COMMERCIAL STATISTICS.

Articles.	1891.	1890.
	Tons.	*Tons.*
Cotton	14,413	8,982
Grain	10,287	3,590
Iron	96	54
Lumber	26,574	32,388
General merchandise	20,261	12,854
Total	71,631	57,868

TOMBIGBEE RIVER FROM ITS MOUTH UP TO DEMOPOLIS.

Survey of this portion of the river was directed by the act of August 11, 1888.

Report upon the survey was submitted December 24, 1889. The project proposed was to obtain a channel of 6 feet depth at ordinary low water by the removal of snags, logs, and overhanging trees, dredging, bank revetment, and the construction of locks and dams.

The length of this section of the river to be improved is 191 miles.

The estimated cost is $508,808.

By the act of September 19, 1890, an appropriation was made of $55,000 for this work.

Operations during the fiscal year consisted in the preparation of a plant, most of which was completed, and the full improvement of the river, according to the project, from the mouth up 65 miles and the partial improvement of 37½ miles more.

An annual appropriation of $10,000 will be required for the preservation of this improvement of the river, and should be made separately from the appropriation for the work proper.

Money statement.

Amount appropriated by act approved September 19, 1890	$55,000.00
June 30, 1891, amount expended during fiscal year	9,648.98
July 1, 1891, balance unexpended	45,351.02
July 1, 1891, amount covered by uncompleted contracts	12,000.00
July 1, 1891, balance available	33,351.02
Amount (estimated) required for completion of existing project	453,808.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

TOMBIGBEE RIVER FROM DEMOPOLIS, ALABAMA, TO COLUMBUS, MISSISSIPPI.

Extending improvement to secure 6 feet draft at low water.—The survey of this section of the river was directed by the act of August 11, 1888. Report upon the survey was submitted December 24, 1889.

The project proposed was to obtain a channel of 6 feet draft by the removal of snags, logs, and overhanging trees, bank revetment, bar improvement by contraction works and dams and gates, at an estimated cost of $779,400.

The length of this portion of the river is 156 miles. An appropriation was made by the act of September 19, 1890, of $15,000.

Digitized by Google

Operations during the fiscal year consisted in the preparation of a plant for the work. Work was commenced during June.

An annual appropriation of about $28,000 will be required for the preservation of the improvement, and should be made separately from the appropriation for this work proper.

Money statement.

Amount appropriated by act approved September 19, 1890	$15,000.00
June 30, 1891, amount expended during fiscal year	288.00
July 1, 1891, balance unexpended	14,712.00
Amount (estimated) required for completion of existing project	764,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Q 3.

IMPROVEMENT OF BLACK WARRIOR RIVER, ALABAMA, FROM TUSCALOOSA TO DANIELS CREEK.

Act of 23d of May, 1828, declared Black Warrior River, Alabama, free from all tolls except such as might be allowed by act of Congress (sec. 5244, R. S., edition of 1878, page 1015).

An examination and partial survey of the river from Locust Fork to Tuscaloosa, 47½ miles, was made in 1874, in accordance with provisions of act of Congress approved June 23, 1884, report of which is contained in Report of Chief of Engineers, 1875.

A survey of the river from forks of Sipsey and Mulberry, 92¼ miles, was made in the fall of 1879, as directed by act of Congress approved March 3, 1879. The report thereon is contained in Report of Chief of Engineers, 1881, Part II, page 1218.

The appropriations have been made as follows:

By act of—	
July 5, 1884	$50,000
August 5, 1886	56,250
August 11, 1888	100,000
September 19, 1890	150,000
Total	356,250

Under the first appropriation a survey for locating works of improvement and for obtaining data upon which to base detailed plans and estimates was commenced in September, 1884, and a report proposing a system of improvement by locks and movable dams was submitted December 19, 1885.

A Board of Engineers for considering the report and project met in Tuscaloosa February 10, 1886, and recommended a change to locks and fixed dams of increased lift.

Plans and estimates prepared in accordance with the recommendation were submitted August 13, 1886, and with slight modifications were accepted by the Board in their report of April 2, 1887. The project was approved May 19, 1887.

The extent of the work is the construction of five locks and dams, with a total lift of 52 feet, between Tuscaloosa and Daniels Creek, 14¾ miles,

Digitized by Google

and its purpose is to furnish slackwater navigation for barges of 6 feet draft.

The locks are to be 52 feet clear width, 322 feet long between hollow quoins, available length 285 feet, and to have a depth of 6½ feet on mitre sills and are to have iron gates. The dams are to be of the rock-fill type.

The estimated cost was $741,670, which will be probably exceeded, as the rock used in construction is found both in quarrying and working more expensive than was anticipated.

Work was commenced in March, 1888, and has been carried on continually since, with the exception of a suspension from September 1 to October 20, 1890, caused by exhaustion of funds.

The land required on the east side of the river was deeded to the United States by the board of mayor and aldermen of the city of Tuscaloosa, Ala., in November, 1887.

For the fiscal year ending June 30, 1888, the work done was preparatory, viz, clearing and grading lock-site, building necessary sheds and quarters, commencing track to quarry, stripping quarry, etc. A lock-tender's house, to serve as engineer's office during construction, was contracted for and completed in May, at a cost of $1,990.

During the fiscal year ending June 30, 1889, the preparatory work was finished, comprising 1¾ miles of track to the quarry, 2 inclines into the lock chamber, forming a circuit for delivering stone, coffer-dam 7 to 12 feet high and 550 feet long completed, 19 derricks framed and put up, bank excavation for lock wall finished, and a derrick-boat and two barges built.

The work of construction proper during the year was:

	Cubic yards.
Stone quarried	7,811
Stone cut	2,364
Stone laid	1,434
Rock excavation in foundation	816
Earth excavation in foundation	1,500

During the fiscal year ending June 30, 1890, the work done was:

	Yards.		Yards.
Masonry laid	7,262	Earth excavated for bank wall	3,780
Dry masonry laid	248	Rock placed in dam	800
Stone cut	950	Rock placed behind bank wall	600
Stone quarried	4,100	Earth placed behind bank wall	941
Rock excavated in lock chamber	1,541	Trestles for needle dam constructed	5

The rock reef on which the lock rests was found so much cut up by crevices that it was found necessary to carry lock, mitre, and needle-dam walls down to the bottom of the lock chamber, thereby increasing the amount of masonry 1,390 yards over the estimate.

During the fiscal year ending June 30, 1891, the work done was as follows:

Funds having become nearly exhausted at the close of the last fiscal year, the work in July and August was confined to completing the masonry of Lock No. 1, and was then suspended until October 20, at which time a new appropriation became available.

Upon resuming work it was found necessary to renew the outfit to some extent. New booms and braces were required for the derricks, and a new road to the works, to avoid trespassing upon private ground. The track to the quarry had also to be relaid with steel rails. This track had originally been a wooden one with a strap rail, for mule service, the supposition at the time being that the haul would not exceed a mile in length. But in reaching out for better quarry facilities it finally became 2 miles long, a distance for which economy required

Digitized by Google

the use of a locomotive and steel track. In addition to these changes and renewals, which were made during the fall and winter, the coffer-dams for Locks No. 2 and 3 were put in with the inclines 3,000 feet long leading down to them.

The quarry heretofore used has been an expensive one to work and only a small force can be advantageously employed on it. It was desired to get one capable of a larger monthly output and at less cost per yard. Explorations failed to indicate a better site along the river bank and it was finally determined to quarry rock from the river bed. Accordingly, in building the coffer-dam for No. 3 it was made long enough (1,300 feet) to inclose an area of about 7 acres, open at the lower end where there is an abrupt fall of 4 feet, so that the inclosure drains itself. It is proposed to use this as a quarry, and it is thought that it can be worked at much less expense than the old one (there being no stripping to do), while the monthly output can be made as large as desired.

Other work for the year is itemized as follows:

Stone quarried, ashlar	cubic yards	846
Stone quarried, backing	do	2,600
Stone cut	do	1,038
Masonry laid	do	567
Paving, foot of bank	square yards	2,040
Turfing, bank slope	do	3,132
Rock excavation in lock pit	cubic yards	1,255
Earth filling behind wall	do	1,900
Rock filling behind wall	do	1,800
Sand hauled for mortar	do	850

PRESENT CONDITION OF THE WORK.

Lock No. 1.—Lock-tender's house built and used at present as an engineer's office.

Masonry completed, except laying the bank wall coping, which is in readiness.

Area back of bank wall paved and bank sloped and turfed.

A flight of fifty steps down to the lock has been constructed.

Base of dam leveled up to elevation 106, the crest being at 114.

Thirteen hundred yards of stone for dam on hand.

Lock No. 2.—Coffer-dam (550 feet long) built, and pump and boiler placed in position for pumping.

Incline into lock chamber graded, 1,500 feet long. Nine hundred and ninety-four yards of cut stone on hand. One hundred and thirty yards of rough ashlar on hand. Twenty-six hundred yards backing on hand. Eight hundred and fifty yards sand for mortar delivered.

Lock No. 3.—Coffer-dam 1,330 feet long completed, inclosing also 7 acres of river bed for quarry. Incline to lock and quarry graded, 1,500 feet long.

It is intended to increase the force during the low-water season, and it is expected that the funds now available will be exhausted by the end of the fiscal year.

COMMERCIAL IMPORTANCE.

Business on the Black Warrior is altogether prospective at present, as it awaits the completion of the improvement now in progress. Its value is therefore necessarily conjectured; but that it will be very great must be evident from the fact that the improvement undertaken, in connection with that in progress below Tuscaloosa, will afford to the Bir-

Digitized by Google

mingham mineral district a water outlet of ample capacity to the seaboard. The exceptionally favorable conditions which have caused such a rapid and extensive development of the mineral resources of this district are offset, to considerable extent, by the fact that the markets for its products are accessible only by long rail routes, the freight charges of which form a high percentage of the cost in market of such bulky and low-priced commodities as coal, ore, and pig-iron. With water transportation the rates would be 50 to 75 per cent. lower, and by competition would compel a reduction of rail rates to the lowest limit that would yield a profit.

Money statement.

July 1, 1890, balance unexpended	$8,200.55
Amount appropriated by act approved September 19, 1890	150,000.00
	158,200.55
June 30, 1891, amount expended during fiscal year	49,622.04
July 1, 1891, balance unexpended	108,578.51
July 1, 1891, outstanding liabilities	6,818.49
July 1, 1891, balance available	101,760.02

Amount (estimated) required for completion of existing project 385,420.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 385,420.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Q 4.

IMPROVEMENT OF NOXUBEE RIVER, MISSISSIPPI.

The examination of this river, provided for by act of Congress approved March 3, 1879, was made during the month of March, 1880, and extended from Macon, Noxubee County, Miss., to its mouth.

Report is contained in the Annual Report of the Chief of Engineers for 1880. The condition of the river when examined was such that during all seasons of the year, and at all stages of water, navigation, except by small flat boats, was practically impossible. Steamboats prior to the building of the Mobile and Ohio Railroad (1859) plied the river. After the construction of this railroad the boats were withdrawn. The river banks then became overgrown with timber, much of which in time fell or slid into the river and caused the formation of a number of shoals and bars. The river being virtually abandoned for the purpose of navigation, the planters living along its banks assisted in obstructing its channel-way by building a number of fish traps and mill dams.

The chief obstruction to navigation consisted in the immense number of trees overhanging the river throughout its entire length. At the time of the examination the minimum depth of the river was found to be (at ordinary low water) 1½ feet, and the average width 60 feet.

The project adopted was to afford a navigable channel during high water, or about five months, to the town of Macon by the removal of overhanging timber from the banks and such obstructions to navigation as might be found in the river.

The estimated cost was $65,245.25.

The appropriations made for the improvement are as follows:

By act of Congress—		By act of Congress—	
June 14, 1880	$12,000	August 11, 1888	$5,000
March 3, 1881	8,000	September 19, 1890	3,000
August 2, 1882	10,000		
July 5, 1884	7,500	Total	53,000
August 5, 1886	7,500		

Digitized by Google

Work was commenced on the improvement during the low-water season of 1880, prosecuted during the fiscal year ending June, 1881, and June 30, 1882, through the month of March, 1883, from September, 1884, to January 12, 1885; from May 23, 1885, to September 23, 1885; from May 26, 1887, to December 15, 1887; from May 15, 1888, to July 20, 1888; from September 20, 1888, to December 8, 1888; from April 1, 1889, to October, 1889.

The condition of the improvement at the end of the fiscal year is a completely improved channel from the mouth of the river up to Macon, 91½ miles, and the project may be considered to be completed.

The amount available and any appropriation that may be made will be applied to the maintenance of improvement.

The river during high water is navigable from its mouth to Macon. This work will require an annual expenditure of $3,000 to maintain it in its improved condition, and no further improvement should be considered until the Tombigbee River below Gainesville is completely improved.

The reduction in freight charges on cotton and produce by railroad, due to the improvement of the river, is estimated at not less and probably much more than than $20,000 per annum.

Money statement.

July 1, 1890, balance unexpended	$287.46
Amount appropriated by act approved September 19, 1890	3,000.00
	3,287.46
June 30, 1891, amount expended during fiscal year	30.00
July 1, 1891, balance unexpended	3,257.46
Amount (estimated) required for preservation of improvements	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 5.

IMPROVEMENT OF PASCAGOULA RIVER, MISSISSIPPI.

By act of—

March 2, 1827, an appropriation was made of	$8,000
May 23, 1828, an appropriation was made of	17,500
August 30, 1852, an appropriation was made of	5,000

The first appropriation was made for removing obstructions from the river and deepening the channel at its mouth; the second one was made for deepening the channel at its mouth, and the third was made for a survey of the river. There are no records in this office of the work done under these appropriations.

In 1870, March 1, a canal (called Noyes Canal) dredged across the bar at the mouth of the river, under a charter from the State of Mississippi to Abram A. Green, to a depth sufficient to admit vessels of 6 feet draft at low tide, was opened by private parties.

The cost of the canal was stated to be $27,000, and for annual maintenance $4,000.

By the act of March 3, 1873, a survey was directed to be made at East Pascagoula Harbor, Mississippi Sound. This survey was made during the same year and report was submitted October 23, 1873. The

Digitized by Google

report is contained in the Annual Report of the Chief of Engineers for 1874.

The plan adopted for the improvement was the dredging of a channel 200 feet wide and 7 feet deep at mean low water through the bar at the mouth of the river, and the removal of snags and overhanging trees throughout its entire length at an estimated cost of $53,800.

The following appropriations were made to carry out this project:

By act of—		By act of—	
June 18, 1788	$10,000.00	August 2, 1882	$8,000.00
March 3, 1879	14,000.00	July 5, 1884	3,000.00
June 14, 1880	20,000.00		
March 3, 1881	4,000.00	Total	59,000.00

At the commencement of the work there was 3 feet on the crest of the bar at mean low water, and the river was much obstructed by snags, logs, and overhanging trees.

Of the aggregete amount of the several appropriations made up to July 5, 1884, less $1,500 alloted for examination, $42,500 was devoted to dredging through the bar at the mouth, and resulted in securing a channel through the bar 180 to 190 feet wide, 7½ to 8 feet deep.

Fifteen thousand dollars of the amount appropriated up to that time was applied to the removal of snags, logs, and overhanging trees. Commencing at the light-house, near the mouth of the river, in the spring of 1882 the work was prosecuted during the working season of 1882, 1883, and 1884. This portion of the work was completed on December 23, 1884, and resulted in securing a navigable channel from the mouth of the river to one-half mile above "Dead Lake," 50½ miles, for vessels drawing 6½ feet, and to the junction of the Leaf and Chickasaha for vessels of lighter draft, during 6 or 8 months of the year. The project was then virtually completed.

By act of—	
August 5, 1886 an appropriation was made of	$20,000
August 5, 1886, transferred amount appropriated for improving Horn Island Pass, act of July 5, 1884	5,000
August 11, 1888, an appropriation was made of	27,000
September 19, 1890, an appropriation was made of	20,000
Total	72,000

Under these appropriations a new project was proposed and approved for securing a channel of navigable width and minimum depth of 12 feet from Moss Point to the anchorage in the bay, at an estimated cost of $78,100, and maintaining the river above Moss Point in its improved condition.

After due advertisements bids for dredging were opened August 17, 1887, and contract entered into with J. H. Gardner September 15, 1887.

Dredging operations were commenced October 8, 1887, and completed April 28, 1888; 113,529 cubic yards were removed. The wreck of the United States snag boat, sunk opposite Moss Point, was removed during May, 1888. Bids for improving Pascogoula River, Mississippi (dredging and building dam), were received and opened November 27, 1888, but prices (17½ cents for dredging and $3,700 for dam) were not satisfactory, and all were rejected.

Bids were again solicited and opened January 20, 1890, and that of George C. Fobes & Co., for dredging, at 16.2 cents per cubic yard, and the Alabama Dredging and Jetty Company, for the dam, $3,350, accepted and contracts entered into.

Dredging was commenced April 16, 1890, and continued to the latter part of July, 1890. The dam was completed in July, 1890.

Digitized by Google

Bids were solicited and opened November 20, 1890, and the lowest, that of the Alabama Dredging and Jetty Company, at 22 cents per cubic yard measured in the scow, accepted and contract entered into. Dredging was commenced in February, 1891, and continued to the end of the fiscal year.

Under the contract with George C. Fobes & Co. 73,619 cubic yards were removed, and under that of the Alabama Dredging and Jetty Company 58,037 cubic yards have been removed up to the 30th of June, 1891. At the beginning of the work under the new project there was a depth of 7 feet through the bar at the mouth of the river, obtained by dredging under the previous project, and a least depth of 9 feet in the river up to Moss Point. Under the new project the work under the first contract was devoted to deepening the cut through the bar at the mouth of the river, and a channel of navigable width and 9½ feet depth obtained. Under the second contract operations were carried on in the river between Moss Point and the mouth, and a channel 80 feet wide and 12 feet deep was obtained.

Under the third contract the work has been devoted to deepening the channel through the bar at the mouth of the river to 12 feet. The plant in use consists of one clam-shell dredge with 3½-yard dipper, two scows, and one tug.

This improvement will not be permanent in its character; $2,500 will be required annually for the removal of snags, etc., in order to maintain the river above Moss Point in its present improved condition.

The present indications are that no annual appropriation will be required for preserving the dredged channel, but that $8,000 at intervals of 3 or 4 years will be ample.

The extent and present condition of the work is as follows:

Extent.	Condition.
I. Snagging and cutting overhanging trees from head to mouth.	Completed, but needs reworking in preservation of improvement.
II. Dredging channel from Moss Point to mouth, of navigable width and 12 feet depth, and construction of dam at Lowry Island.	Completed to a width of 80 feet, and in good condition when last examined. Dam completed.
III. Dredging channel of navigable width and 12 feet depth from the mouth to the 12-foot curve in Mississippi Sound, length of 18,898 feet.	Completed to a width of 80 feet for a distance of 5,100 feet, and to a width of 120 feet for a distance of 1,020 feet.

The amount estimated for completion is in excess of the original estimate, the reasons for which are that, owing to the extreme hardness of a portion of the bottom to be dredged and the smallness of the appropriations made available, the cost of excavation is in excess of that originally estimated.

Money statement.

July 1, 1890, balance unexpended		$20,761.43
Amount appropriated by act approved September 19, 1890		20,000.00
		40,761.43
June 30, 1891, amount expended during fiscal year		24,928.40
July 1, 1891, balance unexpended		15,833.03
July 1, 1891, outstanding liabilities	$4,127.99	
July 1, 1891, amount covered by uncompleted contracts	7,548.80	
		11,676.79
July 1, 1891, balance available		4,156.24

Digitized by Google

Amount (estimated) required for completion of existing project	$69,000.00
Amount (estimated) required for preservation of improvement above Moss Point	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	79,000.00

Abstract of proposals for improving Pascagoula River, Mississippi, received and opened November 20, 1890, by Maj. A. N. Damrell, Corps of Engineers.

[Time of commencing and completing work in accordance with specifications.]

No.	Name and address of bidder.	Price per cubic yard of dredging sand and clay.
		Cents.
1	Alabama Dredging and Jetty Company, Mobile, Ala	22
2	George C. Fobes & Co., Baltimore, Md	23

COMMERCIAL STATISTICS.

Description.	Entries to—						Clearances to—					
	June 30, 1891.			June 30, 1890.			June 30, 1891.			June 30, 1890.		
	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.	No.	Tons.	Crew.
Foreign	114	58,725	1,463	139	93,792	.....	130	96,825	1,786	136	62,067	.....
Coastwise	55	24,010	550	48	13,245	.....	70	27,153	540	42	15,850	.....
American	53	17,648	358	38	11,668	.....	50	14,902	343	66	24,442	.....
Total	222	100,383	2,371	225	118,705	.....	250	138,880	2,669	244	102,359	.....

Tonnage dues, $5,649.29.

Comparative statement of shipments to foreign and coastwise ports.

Articles.	1891.		1890.	
	Tons.	Value.	Tons.	Value.
Lumber	80,413	$888,247	99,776	.....
General merchandise	.....	13,593	88	.....
Total	80,413	901,840	99,864	.....

Q 6.

IMPROVEMENT OF CHICKASAHAY RIVER, MISSISSIPPI.

The act of Congress of August 11, 1888, provided for an examination of the Chickasahay River from its mouth to Enterprise. This examination was made and report submitted on February 16, 1889.

The approved project is to clear the channel from the mouth up to railroad bridge near Shubuta by the removal of logs, snags, and overhanging trees at an estimated cost of $30,000.

Digitized by Google

By act of Congress dated September 19, 1890, $5,000 was appropriated for the improvement of the Chickasahay River.

Work during the fiscal year was confined to preparation of plant for use on the improvement.

The saving to producers by improvement proposed is estimated at about $50,000 annually.

Money statement.

Amount appropriated by act approved September 19, 1890	$5,000.00
July 1, 1891, balance unexpended	5,000.00
July 1, 1891, amount covered by uncompleted contracts	1,250.00
July 1, 1891, balance available	3,750.00
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 7.

IMPROVEMENT OF BLUFF CREEK, MISSISSIPPI.

An act of Congress of August 11, 1888, directed that an examination of this creek should be made from its mouth to the head of navigation.

The examination was made and report submitted February 16, 1889.

The project proposed consisted in the removal of snags, logs, and overhanging trees from the mouth up to Van Cleaves at an estimated cost of $1,000.

By act of Congress approved September 19, 1890, $1,000 was appropriated for this work.

No work was done during the fiscal year, the intention being to use the plant prepared for the Leaf and Chickasahay on this work when the opportunity offered.

The money value of articles transported one way on this creek is estimated at $41,500.

Money statement.

Amount appropriated by act approved September 19, 1890	$1,000.00
July 1, 1891, balance unexpended	1,000.00

Q 8.

IMPROVEMENT OF LEAF RIVER, MISSISSIPPI.

The act of Congress of August 11, 1888, provided for an examination of Leaf River from its mouth to mouth of Bowie Creek, near the New Orleans and North Eastern Railroad.

This examination was made and report submitted on February 15, 1889.

The approved project is to clear the channel from the mouth to the mouth of Bowie Creek for high-water navigation by the removal of snags, logs, and overhanging trees at an estimated cost of $25,000.

Digitized by Google

By act of Congress dated September 19, 1890, $5,000 was appropriated for the improvement of Leaf River. Work during the fiscal year was confined to preparation of plant for use on the improvement.

The present annual commerce to be favorably affected by an improvement is of a value of about $499,600.

Money statement.

Amount appropriated by act approved September 19, 1890	$5,000.00
July 1, 1891, balance unexpended	5,000.00
July 1, 1891, amount covered by uncompleted contracts	1,250.00
July 1, 1891, balance available	3,750.00
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Q 9.

IMPROVEMENT OF HARBOR AT BILOXI BAY, MISSISSIPPI.

The examination of this harbor provided for by the third section of the river and harbor act of March 3, 1881, was made during the months of August and September, 1881.

The report is contained in Annual Report of Chief of Engineers, 1882, Appendix K 27.

The examination showed that between the roadstead and the Back Bay are situated a series of mud flats, called Deer Island Flats, about 1¼ miles east of Biloxi, having a present depth of 4 feet.

The improvement understood to be desired was to secure through these flats a channel 8 feet deep. The estimated cost of the work by dredging was $35,000. The act of Congress, August 2, 1882, appropriated $5,000 for the improvement of the roadstead. No project was submitted, the amount appropriated being deemed insufficient for an economical prosecution of the work. Authority was therefore obtained to defer all action until a further appropriation was made.

The act of July 5, 1884, directed that the balance of the money heretofore appropriated for the roadstead be applied to the deepening of the channel from Mississippi Sound to the wharves of Biloxi. The desired improvement was the deepening of the channel from Mississippi Sound to the wharves of Biloxi from 4½ feet, the least depth at that time, to 8 feet, and the estimated cost was $55,000.

It was not deemed economical or judicious to commence the work with the small amount on hand. Authority was therefore obtained to hold the appropriation until a further one was made to justify a call for bids.

The river and harbor act of August 5, 1886, appropriated $12,500, thus affording, with the balance on hand, the sum of $17,488.55 for carrying on the work of improvement.

The plans and estimates heretofore submitted were based upon an examination only (not sufficient for laying out the work properly), the

Digitized by Google

limit of time and money preventing a complete survey, therefore a careful survey of the channel from Mississippi Sound to the wharves of Biloxi, to locate channel to be dredged, was recommended to be made.

This recommendation was approved and $900 from the amount available was allotted for the work.

A project and estimates, based on the survey made in April and May, 1887, were submitted July 8, 1887, and approved July 13, 1887.

The sum of $16,523.64 was available July 1, 1887, for the improvement of this harbor.

Advertisement and specifications for dredging were prepared and published, bids were opened August 17, 1887, a contract was entered into with George C. Fobes & Co., of Baltimore, Md., at 17 cents per cubic yard, and dredging operations were commenced September 12, 1887, and completed March 2, 1888.

Eighty-four thousand six hundred and eighty-six cubic yards of material were removed.

Bids for improving Biloxi Harbor, Mississippi (dredging), were received and opened November 27, 1888, but as prices (16½ cents per cubic yard) were not satisfactory all were rejected.

Bids were again solicited and opened January 20, 1890, and contract awarded to Alabama Dredging and Jetty Company at 14⅜ cents per cubic yard, measured in the scow. Work commenced July 14, 1890, and continued to November 12, 1890, at which time 97,092 cubic yards had been excavated and the project virtually completed, although a greater width is considered advisable, and it is proposed to expend the appropriation available in that way.

The extent and present condition of the work is as follows:

Extent.	Present condition.
Dredging a channel of 8 feet depth and navigable width through the bar across the west entrance to Biloxi Bay from Mississippi Sound, a distance of 5,351 feet.	Completed to a depth of 9 feet and width of 120 feet, and when last sounded was in good condition, with not less than 9 feet throughout the dredged channel.

The present project is therefore completed, but the amount on hand can be used to advantage in widening the channel already obtained.

The indications are that not more than $8,000 every 4 or 5 years will be ample for the preservation of the improvement.

Before the improvement vessels of more than 5 feet draft could not enter the harbor, while since the improvement vessels of 8 feet draft can come to the wharves of Biloxi.

Money statement.

July 1, 1890, balance unexpended	$18,371.45
Amount appropriated by act approved September 19, 1890	9,000.00
	27,371.45
June 30, 1891, amount expended during fiscal year	16,520.09
July 1, 1891, balance unexpended	10,851.36

Digitized by Google

Abstract of proposals for improving harbor at Biloxi Bay, Mississippi, received and opened November 20, 1890, by Maj. A. N. Damrell, Corps of Engineers.

[Time of commencing and completing in accordance with specifications.]

No.	Name and address of bidder.	Price per cubic yard of dredging sand and soft clay.
		Cents.
1	Geo. C. Fobes & Co., Baltimore, Md	21
2	Alabama Dredging and Jetty Company, Mobile, Ala	20

COMMERCIAL STATISTICS OF BILOXI, MISSISSIPPI.

Articles:	Tons.
Lumber	3,000
Oysters	34,375
Fish	2,988
Shrimp	1,000
General merchandise	73,413
Total	114,776

Q 10.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BELOW JACKSON.

The original project for improving this section of the river was adopted in 1880, the object being to obtain a navigable channel 5 feet deep at low water from Jackson down to the mouth by the removal of snags, stumps, roots, sunken logs, and trees, and the clearing of banks of overhanging trees, at an estimated cost of $95,940, based upon the report of a survey made under direction of Capt. C. W. Howell, Corps of Engineers, during March and April, 1879.

Upon an examination made in December, 1884, it was found that a 5-foot clear channel at low water was not practicable by the method proposed, but that a 2-foot channel at low water could be obtained in that manner, and was all that the present commerce of the river required.

Upon that examination the original estimate was increased $50,000. (See Annual Report, 1885–'86, Q 9, page 1,367.)

In addition to the improvement of the river proper, the increased lumber trade of the mills situated on the river demands the deepening of the channel over the bar at the mouth of East Pearl River to 12 feet, a rough estimate of the cost of which is $20,000.

The following appropriations have been made:

By act of—	
June 14, 1880	$30,000
March 3, 1881	25,000
August 2, 1882	15,000
July 5, 1884	10,000
August 5, 1886	13,125
August 11, 1888	15,000
September 19, 1890	20,000
Total	128,125

Under these appropriations work was commenced by contract in December, 1880. Working from Jackson down, 295 miles of river were partially improved.

Digitized by Google

August 23, 1882, contract work was completed and accepted.

In November, 1882, work on the improvement by hired labor was commenced and was suspended in November, 1883; resumed June, 1884; suspended September 1, 1884, on account of high water; resumed December 1, 1884; suspended June 30, 1885, on account of lack of funds; resumed in September, 1885; suspended March 30, 1886, on account of lack of funds; resumed September 5, 1886; suspended November 22, 1887, on account of lack of funds; resumed October 20, 1888, and suspended October 23, 1889, on account of lack of funds.

Work on the construction of a log flat was commenced in May, 1891, and completed in June, 1891. No other work was done during the fiscal year ending June 30, 1891.

The following is a statement of work performed from 1884 up to the 30th of June, 1890:

Snags removed		7,164
Roots removed		6,808
Sunken logs removed		3,004
Sunken trees removed		2,777
Stumps removed and blasted		2,229
Knees cut and removed		87
Standing trees cut and removed		1,454
Overhanging trees cut and removed		20,141
Standing trees deadened		2,769
Sand and clay removed	cubic yards..	11,739½
Cane removed	running yards..	9,422
Piles driven for jetties		256
Willows planted for jetties	cords..	666
Willows cut, made into mattresses, and sunk	do..	618½
Trees felled, cut in lengths, and sunk for jetties		1,531
Sunken logs and trees pulled and sunk for jetties		116
Clay dug out, wheeled, transported, and filled in in jetties	cubic yards..	3,220

Nearly one-half of the amount appropriated has been expended in the removal of the annual accumulation of snags, logs, etc., or in preservation of the improvement.

Fifty-one miles of river from the mouth, at the Rigolets, to Wakiah Bluff have been fully improved. Fifty-five miles of river from Wakiah Bluff to Wheat's Field have been improved for a 100-foot wide channel, and 50 miles of river from Wheat's Field to Columbia have been partially improved. From Columbia to Jackson the river had been partially improved by contract. No other work has been done on that section since, and it remains in about the same condition.

The condition of this part of the river on June 30, 1891, is such as to allow light-draft boats to navigate from the mouth, at the Rigolets, La., to Wheat's Field, Miss., 106 miles, all the year round; from Wheat's Field to Columbia, Miss., 50 miles, on a 6-foot rise, and from Columbia to Jackson, Miss., 158 miles, only on a 7-foot rise, and then it is dangerous.

The benefits that are derived by the improvement of this section of river are greater security to navigation between New Orleans, La., and Columbia, Miss., and other towns and settlements situated on the river, and reduced rates of freight and insurance on merchandise and produce. Large tracts of rich and valuable bottom lands have been reclaimed by the improvement and are now being cultivated.

It is proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1893, to continuing the improvement of the river for a 2-foot channel, at low water, between Columbia and Jackson.

It is also proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1893, for deepening the channel over

Digitized by Google

the bar at the mouth of East Pearl River to dredging a channel 12 feet deep at mean low water as far as the funds available will permit.

Owing to caving banks and shifting of the channel the improvements so far made and contemplated are not permanent. An annual expenditure of $5,000 will be required to maintain the river in the condition contemplated by the plan of improvement.

Money statement.

July 1, 1890, balance unexpended	$4,021.45
Amount appropriated by act approved September 19, 1890	20,000.00
	24,021.45
June 30, 1891, amount expended during fiscal year	1,335.25
July 1, 1891, balance unexpended	22,686.20
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 11.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN JACKSON AND CARTHAGE.

An examination of this part of the river was made in 1879, and report thereon is contained in the Annual Report of the Chief of Engineers of 1879. (Appendix K 2.)

The original project for the improvement of this part of the river consisted in the removal of snags, logs, overhanging trees, etc., and was to afford a clear channel of navigable width, 5 feet deep, at a low stage of the river, from Jackson to Carthage, a distance of 105 miles, at an estimated cost of $21,000.

An examination made in January, 1887, showed that a clear 5-foot channel at low water was not practicable by the method proposed on this section of the river, but that a 2-foot channel at low water could be obtained in that manner and was all that the present commerce of the river required.

Upon that examination the original estimate of the cost of the improvement was increased $29,000. (See Annual Report, 1886–1887, Q 9, page 1336.)

The following appropriations have been made:

By act of—	
March 3, 1879	$6,000
June 14, 1880	7,500
March 3, 1881	2,500
August 2, 1882	2,500
August 6, 1886	2,250
August 11, 1888	2,500
September 19, 1890	2,500
Total	25,750

Under the appropriations work was commenced by contract November 20, 1879; the work, however, not proving satisfactory, the contracts were annulled September 22, 1882, and the work was continued by hired labor during the low-water seasons of 1883 and 1884; sus-

Digitized by Google

pended in January, 1885, on account of lack of funds, resumed January 1, 1887; suspended January 29, 1887, on account of high water. resumed August 1, 1887; suspended November 30, 1887, on account of lack of funds, resumed in September, 1888, and suspended December 31, 1888, on account of high water, resumed November, 16, 1890; suspended in January, 1891, on account of high water.

The following is a statement of work up to June 30, 1890:

Snags cut and removed	22,582
Stumps cut and removed	930
Sunken logs cut and removed	4,020
Overhanging trees cut and removed	372

The work performed during the fiscal year ending June 30, 1891, was as follows:

Snags cut and removed	8,025
Sunken logs cut and removed	1,128
Sunken trees cut and removed	793
Stumps cut, blasted, and removed	401
Overhanging trees cut and removed	16

About one-half of the appropriations have been expended in the removal of the annual accumulation of snags, logs, etc., or in preservation of the improvement.

One hundred and two miles of river from Carthage down have been fully improved, and 3 miles, down to Jackson, have been partially improved.

The condition of the river on June 30, 1891, is such as to allow light-draft boats to navigate with comparative safety on a 3-foot rise above ordinary low water from Carthage down, 102 miles, and the remaining distance down to Jackson, 3 miles, on a 4-foot rise.

Owing to caving banks and shifting of the channel the improvements so far made are not permanent. An annual expenditure of $2,400 will be required to maintain the river in the condition contemplated by the plan of improvement.

The reduction and saving in railroad freights, as well as the reduced rates of insurance on freights, both up and down stream, due to river competition, are considerable. It is proposed to apply any appropriation that may be made for the fiscal year ending June 30, 1893, to completing 3 miles above Jackson and to rework the 102 miles below Carthage.

The following are the vessels that have navigated this portion of the river during the last fiscal year: 1 stern wheel steamboat, 6 flatboats, 1 propeller; total tonnage, 355.

Fifteen hundred tons of general merchandise, grain, fertilizers, machinery, etc., were carried upstream. Approximate value, $100,000. Fourteen thousand tons of cotton, staves, lumber, shingles, sawlogs, fowls, produce, etc., were transported downstream. Approximate value, $220,000.

Money statement.

July 1, 1890, balance unexpended	$103.27
Amount appropriated by act approved September 19, 1890	3,000.00
	3,103.27
June 30, 1891, amount expended during fiscal year	1,632.37
July 1, 1891, balance unexpended	1,470.90
Amount (estimated) required for completion of existing project	23,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	23,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Digitized by Google

Q 12.

IMPROVEMENT OF PEARL RIVER, MISSISSIPPI, BETWEEN EDINBURG AND CARTHAGE.

A survey of this part of Pearl River was made during the month of November, 1883, and report thereon is contained in the Annual Report of the Chief of Engineers of 1884, Appendix Q 18.

The project for the improvement of this part of the river was to afford a high-water channel from Edinburg to Carthage, a distance of 24¾ miles, for 6 or 8 months of the year, at an estimated cost of $13,464.

The following appropriations have been made:

Act of—	
July 5, 1884	$2,500
August 5, 1886	2,250
August 11, 1888	5,000
September 19, 1890	5,000
Total	14,750

Under the appropriations work was commenced on November 17, 1884, suspended January 23, 1885, on account of high water; resumed September 3, 1885, suspended September 30, 1885, on account of lack of funds; resumed November 16, 1886, and suspended December 18, 1886, on account of high water; resumed December 1, 1887, suspended December 27, 1887, on account of high water; resumed June 1, 1889, and suspended December 12, 1889, on account of high water.

The following is a statement of work up to June 30, 1890:

Snags, stumps, sunken logs, and trees cut and removed	121,855
Trees standing in channel removed	368
Fallen trees removed	94
Overhanging trees cut and removed	10,467
Banks cleared of brush.....yards..	6,491

No work was done during the fiscal year ending June 30, 1891.

The entire distance of this part of the river from Edinburg to Carthage, 24¾ miles, has been fully improved and the project completed.

The condition of the river on June 30, 1891, is such as to allow light-draft boats to navigate with comparative safety from Edinburg to Carthage on a 4½-foot rise above ordinary low water.

Owing to caving banks and shifting of the channel the improvements so far made are not permanent, and it is estimated that an annual expenditure of $500 will be required to maintain the river in the condition contemplated by the plan of improvement.

The reduction and saving in railroad freights, as well as the reduced rates of insurance on freights both up and down stream, due to river competition, are considerable.

Only one steamboat, of 110 tons burden, has been employed on the river during the last fiscal year, carrying about 900 tons general merchandise, grain, fertilizers, etc., upstream. Approximate value, $70,000. Four hundred tons of cotton, country produce, etc., were carried downstream. Approximate value, $40,000.

Money statement.

July 1, 1890, balance unexpended	$629.53
Amount appropriated by act approved September 19, 1890	5,000.00
	5,629.53
June 30, 1891, amount expended during fiscal year	600.66
July 1, 1891, balance unexpended	5,028.87

Digitized by Google

Amount (estimated) required for preservation of improvement	$500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 13.

IMPROVEMENT OF BOGUE CHITTO, LOUISIANA.

An act of Congress of August 11, 1888, directed an examination of this river to be made.

The examination was made and report submitted June 24, 1889.

The project proposed consisted in closing the west mouth and the removal of snags, logs, overhanging trees, and fish-traps from the other mouth up to Alford Bridge, so that the river could be used by small river steamers of 3 feet draft the greater part of the year. The estimated cost was $55,000.

Five thousand dollars was appropriated by act of Congress approved September 19, 1890, to be expended from its mouth to where the first bridge obstructing navigation is located.

Work during the fiscal year was confined to the preparation of a plant for use on the improvement.

The annual saving in freight to the present commerce that would be effected by the improvement of the river is estimated at about $30,000.

Money statement.

Amount appropriated by act approved September 19, 1890	$5,000.00
July 1, 1891, balance unexpended	5,000.00
July 1, 1891, amount covered by uncompleted contracts	1,250.00
July 1, 1891, balance available	3,750.00
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Q 14.

PRELIMINARY EXAMINATION OF SUCARNOOCHEE RIVER, ALABAMA, FROM ITS MOUTH TO THE MOBILE AND OHIO RAILROAD BRIDGE.

[Printed in House Ex. Doc. No. 116, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 22, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report, dated November 19, 1890, from Maj. A. N. Damrell, Corps of Engineers, giving results of preliminary examination of Sucarnoochee River, Alabama, "from its mouth to the Mobile and Ohio Railroad Bridge," made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Damrell reports that although he considers this river worthy

Digitized by Google

of improvement to a certain extent, still it is probably of less importance than any river in charge of his office, and work on it should be postponed until the more important ones are finished. Taking into consideration the estimates of Major Damrell, Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, states that he does not think the river worthy of improvement by the United States, and I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR A. N. DAMRELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Mobile, Ala., November 19, 1890.

GENERAL: I have the honor of submitting the following report of a preliminary examination of the "Sucarnoochee River, Alabama, from its mouth to the Mobile and Ohio Railroad bridge," directed by the river and harbor act of September 19, 1890, and assigned to my charge by letter from the office of the Chief of Engineers of September 20, 1890.

The character of the river is shown in the following table:

Section.	Length of section.	Width of stream.		Width of channel.		Depth of low water.		Extreme high water.	Height of banks.
		Min.	Max.	Min.	Max.	Extreme.	Mean.		
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Mobile and Ohio Railroad bridge to Harper's bridge.	14	55	90	40	65	1.5	2.0	20	8
Harper's to Payneville bridge	6	35	100	30	70	1.5	2.0	20	10
Payneville to Horn's bridge	20	45	90	35	65	2.0	2.5	18	12
Horn's to Alabama Great Southern Railroad bridge.	30	25	100	25	70	3.5	4.0	17	12
Alabama Great Southern Railroad to East Tennessee, Virginia and Georgia bridge.	18	50	85	35	60	3.5	4.0	16	12
East Tennessee, Virginia and Georgia to Pipkins' bridge.	5	40	85	35	60	3.9	4.7	15	11
Pipkins' to mouth of river	24	50	100	40	70	4.4	5.4	12	10

Section.	Character of bed.	Character of banks.	Approximate discharge per minute at a stage 3 feet above mean low water.	Character of obstructions.
			Cubic feet.	
Mobile and Ohio Railroad bridge to Harper's bridge.	Clay and sand.	Alluvial ..	30, 600	Stumps, fallen and overhanging trees, fish traps.
Harper's to Payneville bridge	Clay and sand. Rotten limestone.	Alluial, with an occasional outcrop of rotten limestone.	34, 000	
Payneville to Horn's bridge	....do		38, 200	
Horn's to Alabama Great Southern Railroad bridge.	....do		41, 500	
Alabama Great Southern Railroad to East Tennessee, Virginia and Georgia bridge.	....do		44, 700	
East Tennessee, Virginia and Georgia to Pipkins' bridge.	Clay and sand.	Alluvial	46, 000	
Pipkins' to mouth of river	....do	....do	50, 000	

Digitized by Google

This river flows through Kemper County, Miss., and Sumter County, Ala., and empties into the Tombigbee 15¾ miles below Demopolis. The length of river examined is approximately 117 miles, and the drainage area is about 1,000 square miles. The fall is about 132 feet, or 1.12 feet to the mile. The discharge is approximately 500 cubic feet per second at the railroad bridge, and 800 cubic feet per second at the mouth on a stage 3 feet above mean low water. There are only two rapids on the river, about 4 and 5 miles respectively, below Payneville Bridge, the first 450 feet long, with a fall of six-tenths of a foot, and the second 275 feet long, with a fall of three-tenths of a foot.

There are three railroad bridges (Mobile and Ohio, Alabama Great Southern, and East Tennessee, Virginia and Georgia) and seven county bridges crossing the river, all of wood, except the Mobile and Ohio, which is of iron; none less than 23 feet above low water. Those at Harper's, Payneville, and Horn's are 40 feet between piers; all others 70 to 90 feet.

The river is not susceptible of being made navigable at low water for steamboats at any reasonable expenditure, considering the amount of commerce to be benefited.

The obstructions that would have to be removed to render it navigable at a stage 5 feet above mean low water, or for about 5 months of the year, are logs, stumps, snags, overhanging timber, and 7 fish traps. The cost of work is estimated not to exceed $35,000.

The only commerce on the river at present is the rafting of a small amount of timber.

The valley of the river abounds in white oak, hickory, long-leaf pine, ash, poplar, beach, and sweet gum.

The saving in freight on cotton and plantation supplies to the planters near and on the river by the improvement suggested would be probably about $2,500 per annum.

In my opinion the river is worthy of improvement, for the reason that the cost will not exceed $35,000, while the annual saving to the present commerce will not be less than $2,500, with a good prospect of a considerable increase in the future.

Although, as stated, I believe this river is worthy of improvement to the extent proposed, still it is probably of less importance than any river in charge of this office, and work on it should be postponed until the more important ones are finished.

No survey will be needed, as the preliminary examination has given sufficient information for all practical purposes.

A tracing of a map* is inclosed herewith, showing the river, its tributaries, and the approximate location of the bridges, fish traps, etc.

Respectfully submitted.

A. N. DAMRELL,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

*Not printed.

Digitized by Google

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 18, 1890.

Respectfully forwarded to the Chief of Engineers.

The district engineer estimates that the annual saving in freights resulting from the expenditure of $35,000 will be $2,500 per annum. As the interest on the $35,000 and the expenses of maintaining the improvement would probably equal $2,500 per annum, I do not think the river worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Digitized by Google

Digitized by Google

APPENDIX R.

INSPECTION OF THE IMPROVEMENT OF THE SOUTH PASS OF THE MISSISSIPPI RIVER.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, INSPECTING OFFICER, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 1, 1891.

GENERAL: I have the honor to submit my annual report upon the improvement of South Pass of the Mississippi River, and to transmit herewith the report of Mr. C. Donovan, assistant engineer. The latter report and accompanying charts contain all details relative to the maintenance of the works of construction and the channel.

Up to February 1, 1891, Capt. W. L. Fisk, Corps of Engineers, was the inspecting officer.

The channel, as required by law, was maintained during the year except for 15 days. During 3 days in April the channel in the pass itself, at one point, was but 25 feet in depth, and for 12 days the jetty channel had a central depth of from 27.5 to 29.4 feet instead of 30 feet.

Beyond the ends of the jetties the most direct channel varied in depth from 26 to 31 feet, but in the channel turning to the eastward the depth varied but slightly, and a depth of more than 30 feet was maintained during the year.

The fluctuations in the depth of the channel throughout South Pass proper, that is, the channel from the main river to the head of the jetties, were of no special importance during the year, and, with the exception of the 3 days above mentioned, the least depth was in Grand Bayou Reach and was 27 feet, and the least width of the 26-foot channel was 160 feet.

In the fan-shaped area beyond the ends of the jetties there was an average shoaling of 2.7 feet during the year. For details concerning this area I invite attention to Mr. Donovan's report.

ESTIMATE OF FUNDS REQUIRED FOR EXAMINATIONS AND SURVEYS AT SOUTH PASS OF THE MISSISSIPPI RIVER DURING THE FISCAL YEAR ENDING JUNE 30, 1893.

1 assistant engineer	$2,700
1 recorder	1,200
1 steam engineer	1,200
1 water-level observer	120

Digitized by Google

6 seamen	$3,370
Rent of office	180
Rent of quarters for assistant engineers	240
Mileage and traveling expenses	200
Repairs to launch and boats	700
Supplies for launch and office	300
Contingencies	2,000
Total	12,210

Money statement.

July 1, 1890, balance unexpended	$11,042.27
Amount appropriated by act of August 11, 1888	10,000.00
	21,042.27
June 30, 1891, amount expended during fiscal year	11,042.27
July 1, 1891, balance unexpended	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	12,210.00

Respectfully submitted.

JAMES B. QUINN,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Statement of expenditures on account of appropriation for "examinations and surveys at South Pass of the Mississippi River" for the fiscal year ending June 30, 1891, made in compliance with section 4 of river and harbor act of August 11, 1888.

Amount appropriated by act of August 11, 1888	$10,000.00

EXPENDITURES.

1 assistant engineer, 12 months, at $200	$2,400.00
1 recorder, 12 months, at $100	1,200.00
1 engineer, launch, 11 3/4 months, at $100	1,180.00
2 first-class seamen, 18 1/2 months, at $70	1,295.00
2 first-class seamen, 24 months, at $65	1,560.00
1 first-class seaman, 5 1/2 months, at $60	324.00
1 first-class seaman, 4/30 month, at $75	10.00
1 water-level observer, 12 months, at $10	120.00
1 clerk, 1 month, at $100	100.00
Rent of office and quarters at Port Eads, La., 12 months, at $35	420.00
Rent of office U. S. engineer at New Orleans, La., 1 month, at $45	45.00
	8,654.00
Traveling expenses, assistant engineer	41.70
Stationery	71.98
Repairs to steam launch *General Reese*	892.53
Ship chandlery, hardware, etc	265.44
Miscellaneous expenditures	74.35
Total expenditures	10,000.00

Digitized by Google

REPORT OF MR. C. DONOVAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Fort Eads, La., July 1, 1891.

SIR: I have the honor to report upon the improvement of South Pass of the Mississippi River during the fiscal year ending June 30, 1891, relative to the amount and character of the work done, the present condition of the works, and the results which they have produced.

This work is carried on under the direction of Messrs. James F. How and Estill McHenry, of St. Louis, Mo., by authority granted them as the legal representatives of James B. Eads, deceased, in the act of Congress approved March 3, 1875.

The following charts accompany this report:

No. 1. Chart of the channel from South Pass light-house, through the jetties, to deep water in the Gulf.

No. 2. Chart of a part of the Gulf of Mexico, showing depths out to that of 100 feet.

No. 3. Chart of a part of South Pass from South Pass light-house to Grand Bayou.

No. 4. Chart of a part of South Pass from Grand Bayou to the Head of the Passes.

No. 5. Chart of the Head of the Passes.

No. 6. Plan and comparative profiles of South Pass.

No. 7. Diagrams showing changes in the Gulf for each year from 1876 to 1891.

AT THE HEAD OF THE PASSES.

The only structures at this locality which have required or received any attention for several years are those known as West T-Head and Upper Dam. To the former, 257 cords of willows, weighted with earth, were added during the year. The work is very substantial and in good condition.

The western end of Upper Dam was rebuilt for a length of 53 feet, most of which had washed out. The scouring at the east end of the dam during the last high river caused a rapid undermining of the work, and 180 feet of it was carried away. The portion now remaining is 720 feet in length; it is in good condition and well supported by the land formation which it has caused below it.

The following materials were used in this dam during the year: Twenty-six piles, 364 linear feet of 12 by 12 inch timber, 216 cords of willows, 72 cubic yards of stone, 32 screw bolts seven-eighths of an inch in diameter and 2 feet long, and 8 drift bolts three-fourths of an inch in diameter and 1½ feet long.

For the location of these works, see Chart No. 5.

MATTRESS SILLS ACROSS SOUTHWEST AND NORTHEAST PASSES.

No change of importance, and practically none at all, has taken place in these sills during the year. For a distance of 1,500 feet from the east end of Northeast Pass sill sediment was deposited upon it, the amount varying in vertical height from 1 foot near the shore to 6 feet, at a distance of 1,250 feet from the east end.

IN SOUTH PASS.

In Goat Island Reach wing dam No. 2 was repaired by using 19 piles, 190 linear feet of 12 by 12 inch timber, 225 cords of willows, 16 screw bolts, and 8 drift bolts. This dam and also one No. 9 are in good condition, but the other ones in this reach have deteriorated to such an extent that they are of no value.

The wing dams in Goat Island Reach have received no additional work during the year. Numbers 6, 7, 8, 10, 11, and 12 are in fair condition, but if the other ones are again required it will be necessary to renew them.

The locations of the dams in these reaches are shown on Charts 3 and 4.

AT THE MOUTH OF SOUTH PASS.

East Jetty.—The work on this jetty, during the year, was principally confined to continuing the crib work capping upwards from a point 5,126 feet below East Point, where it ended last year, to a point 4,326 feet below East Point, a distance of 800 feet; over this distance 14 cribs were placed, each being 56 feet long, 9 feet wide, and 3 feet high.

One crib of the same dimensions was placed on the sea side of the concrete wall,

Digitized by Google

at a point 6,370 feet below East Point, as a protection to its foundation, and at a point 8,560 feet below East Point 65 cubic yards of stone were used for the same purpose.

Previous reports contain all details of construction, and the location of all work referred to is shown on chart No. 1, and the character of the same represented.

The concrete work on this jetty remained in good condition during the year; from March 31, 1890, to June 1, 1891, its subsidence averages 0.16 of a foot.

In the maintenance of this jetty the following materials were used during the year: 9,347 linear feet of 12 by 12 inch timber, 15,120 feet B. M. of 3 by 12 inch plank, 240 seven-eighth inch screw bolts from 2 to 3 feet long, 1,035 three-quarter inch drift bolts from 16 to 20 inches long, and 498 cubic yards of stone.

West Jetty.—As will be seen from chart No. 1, this jetty is almost completely buried by the land formation which has been so rapid since the construction of the work, and it is not probable that it will ever require further attention.

Inner East Jetty.—Over the outer 353 feet in length of this jetty a continuous crib was built in place upon the willows previously placed, and which had become well compressed by the weight of a large quantity of stone upon them, which was removed and reused in loading the crib. For a distance of 60 feet from the sea end it is 17 feet wide, thence for a distance of 250 feet it is 11 feet wide, the remainder being from 7½ to 9½ feet wide. It is 5 feet high on the river side and 4 feet on the sea side.

At other localities willows and stone have been added to this work, and new piles driven between the older ones, which have become badly decayed above the water.

The work is in good condition and the following materials were used in its maintenance: 6,030 linear feet of 12 by 12 inch timber, 855 feet B. M. 3 by 12 inch plank, 431 piles, 5,054 cords of willows, 1,320 cubic yards of stone, 76 screw bolts, and 1,397 drift bolts.

Inner West Jetty.—For a distance of 618 feet from the outer end of this jetty two cribs were built in place on top of the willows, and surrounding one of the rows of piles in the jetty. They are 287 and 331 feet long, 9 feet wide, and from 3 to 5 feet high; they are filled with stone and covered, and make a very substantial capping to this more exposed portion which was often damaged by heavy seas when the willows were simply weighted with stone.

At other localities, where required, willows and stone were added to the jetty, and a few piles renewed. The work is maintained in good condition.

In its maintenance during the year the following materials were used: 6,575 linear feet of 12 by 12 inch timber, 37 piles, 3,311 cords of willows, 459 cubic yards of stone, 111 screw bolts, and 1,539 drift bolts.

WING DAMS.

A crib 64 feet long, 6½ to 7½ feet wide, and from 2½ to 3 feet high, was added to the dam which connects the outer ends of the main and inner east jetties; and one 54 feet long, 12 feet wide on the bottom, 8 to 9 feet wide on top, and 4 feet high, was added to Dam 29; another 41 feet long, 6 to 9 feet wide, and 5 feet high, was placed upon an old dam of palmetto cribs just below the West Light.

Dams 9, 10, 30, 31, 32, 35, and 37 were repaired or had materials added to them, and 22 and 24 were built up between the east and inner east jetties in order to prevent currents between these works, and induce a more rapid shoaling.

These structures, though mostly temporary in character, are, where they are of importance, maintained in good condition. In their maintenance during the year the following materials were used: 1,058 linear feet of 12 by 12 inch timber, 4 piles, 406 cords of willows, 140 cubic yards of stone, 57 screw bolts, and 553 drift bolts.

DREDGING.

During the year dredging has at times been resorted to in order to maintain the required channel, most of that work having been done during the months of August, October, and December, 1890, and May and June, 1891. The time during which dredging was done amounted to 82 days, of 10 hours each.

THE PLANT.

A barge 90 feet long, 19 feet wide, and 5 feet depth of hold was built; a tug and small launch repaired, and 10 mooring piles driven along the banks of the pass.

THE FORCE EMPLOYED.

The average force employed during the year, including officers, mechanics, and laborers, was 41 in number.

Digitized by Google

EXAMINATIONS AND SURVEYS.

The results of examinations and surveys made during the year were reported monthly, and the same are embodied in this report. The results of more extended surveys recently made are given on charts in tabular form, or graphically represented and are compared with similar results obtained since 1875.

The results of tidal, sediment, and velocity observations for the year add nothing of special interest to similar results extending over many years and which are published in previous reports, and therefore I have omitted the year's record from this report.

AT THE HEAD OF THE PASSES.

The chart of this survey is No. 5. This area is constantly changing from the time the current obtains scouring power from a rising river until it ceases when the river falls, and as the survey was made while the river was rising, and when it had nearly reached its highest point, the chart represents rather an abnormal condition of the channel.

The changes in depth over the area covered by this survey were comparatively slight and unimportant during the year, except in Northeast Pass, in which there was a marked shoaling.

By using comparative profiles on line E F, and going downward from a point 1690 feet below the upper limit of the survey, I find a shoaling of 9 feet down to the mattress sill, below which there was a shoaling of 6 feet. A similar comparison made on section I J shows that this shoaling extends 2,500 feet from the east shore.

Making the same comparison with results in 1875 there has been a shoaling of 5 feet down to the sill, and of 2 feet below it.

Southwest Pass deepened slightly during the year, and along the line A B South Pass shows an unimportant shoaling.

As a general result this area shoaled during the year, and has deepened since 1875; the important deepening being in the channel into South Pass which may be seen from profiles on chart No. 6.

The depth of channel from the main river into South Pass varied from 28 feet in August, 1890, to 30 feet in March, 1891. At present the least depth is 29 feet, and at all times the 26-foot channel was very wide.

SURVEY OF SOUTH PASS FROM ITS HEAD TO SOUTH PASS LIGHT-HOUSE.

The usual complete survey of South Pass was made during the month of October; the charts are Nos. 3 and 4. In comparison with a survey made a year earlier I find in the first 2 miles above East Point a deepening averaging about 2 feet in vertical height. Throughout the remainder of the pass there was a shoaling, slight in some reaches and very pronounced in others, being least in Grand Bayou and Goat Island reaches. The greatest shoaling was from 7¼ to 9 miles above East Point, where it averages 3 feet in vertical height.

By reference to chart No. 6, it will be seen that since 1875 there has been a decided shoaling throughout the pass, except in a reach 1½ miles in length above East Point.

On April 11, 12, and 13, at a locality 1,300 feet below South Pass Light-House, the available depth was but 25 feet. The shoaling was caused by the temporary lodgment of volumes of sand which moves along the bottom of the pass during a certain high stage of the river.

Aside from the shoaling mentioned, the least depth in the pass during the year obtained in Grand Bayou Reach, and was 27 feet; the least width of the 26-foot channel at any time was 160 feet. This locality is at the present time the shoalest place in the pass; the central depth is 27.9 feet, and the 26-foot channel is 340 feet wide.

The width and depth of channel at other localities throughout the pass is substantially as shown on charts 3 and 4, from which the following table is compiled:

Digitized by Google

Tabulated statement of the depth and width of channel throughout South Pass of the Mi sissippi River, from East Point to 30-foot depth in the main river, given in separa reaches one-fourth of a mile in length, from a survey made in October, 1890.

Locality.		Least available depth.	Least width for—	
From—	To above East Point.		26-foot depth.	30-foot depth.
East Point	¼ mile	29.0	220	(1)
Above East Point:				
¼ mile	½ mile	30.0	410	80
½ mile	¾ mile	33.0	330	210
¾ mile	1 mile	35.8	330	180
First mile		29.0	220	.....
1 mile	1¼ miles	31.2	350	160
1¼ miles	1½ miles	30.1	410	80
1½ miles	1¾ miles	30.2	420	80
1¾ miles	2 miles	30.0	400	20
Second mile		30.0	350	20
2 miles	2¼ miles	31.8	460	280
2¼ miles	2½ miles	31.5	440	300
2½ miles	2¾ miles	32.0	440	350
2¾ miles	3 miles	32.0	430	370
Third mile		31.5	430	280
3 miles	3¼ miles	32.0	410	220
3¼ miles	3½ miles	31.6	400	170
3½ miles	3¾ miles	31.4	400	150
3¾ miles	4 miles	32.8	390	200
Fourth mile		31.4	390	150
4 miles	4¼ miles	33.0	410	250
4¼ miles	4½ miles	32.5	440	330
4½ miles	4¾ miles	35.3	430	250
4¾ miles	5 miles	37.0	290	180
Fifth mile		32.5	290	180
5 miles	5¼ miles	28.4	280	(2)
5¼ miles	5½ miles	27.3	440	(3)
5½ miles	5¾ miles	28.4	290	(4)
5¾ miles	6 miles	30.0	270	50
Sixth mile		27.3	270	.....

Locality.		Least available depth.	Least wid for—	
From—	To above East Point.		26-foot depth.	30-foot dep
Above East Point—Continued.				
6 miles	6¼ miles	28.3	370	(5)
6¼ miles	6½ miles	28.3	340	(6)
6½ miles	6¾ miles	30.3	350	7
6¾ miles	7 miles	30.6	400	10
Seventh mile		28.3	340	....
7 miles	7¼ miles	31.7	400	1
7¼ miles	7½ miles	31.4	430	2
7½ miles	7¾ miles	36.0	370	2
7¾ miles	8 miles	35.5	360	2
Eighth mile		31.4	360	1
8 miles	8¼ miles	34.3	360	3
8¼ miles	8½ miles	32.4	420	2
8½ miles	8¾ miles	34.0	300	2
8¾ miles	9 miles	36.5	270	2
Ninth mile		32.4	270	2
9 miles	9¼ miles	34.4	270	1
9¼ miles	9½ miles	28.5	340	(7
9½ miles	9¾ miles	33.6	390	2
9¾ miles	10 miles	47.0	350	3
Tenth mile		28.5	270	....
10 miles	10¼ miles	37.0	370	3
10¼ miles	10½ miles	41.0	400	3
10½ miles	10¾ miles	40.0	390	3
10¾ miles	11 miles	36.0	450	3
Eleventh mile		36.0	370	1
11 miles	11¼ miles	52.0	(*)	(*
11¼ miles	11½ miles	28.0	750	(8
11½ miles	11¾ miles	28.0	(*)	(9
11¾ miles	12 miles	30.+†	(†)	(†
Twelfth mile		28.0	750	...

* Very wide.

† In Mississippi River, above the Head of the Passes.

Length of the portion of this reach lacking a central depth of 30 feet.

	Feet.
(1)	80
(2)	190
(3)	880
(4)	380
(5)	890
(6)	830
(7)	
(8)	
(9)	
Total length of channel in 12 miles	5,

THE CHANNEL THROUGH THE JETTIES.

The channel through the jetties is shown on Chart No. 1, and the variations in t depth of it may also be seen from a profile on Chart No. 6.

At times during the year it was necessary to dredge at some localities in order maintain the required "channel 26 feet in depth, not less than 200 feet in width the bottom, and having through it a central depth of 30 feet without regard width," yet, during the period from April 25 to May 6, both dates inclusive, t depth was not maintained at places within a reach from 1,500 to 2,700 feet bel East Point. Volume after volume of clear, fine sand entered this reach and seem to be constantly in motion, and for several days the result of the work of a pow ful dredge was scarcely appreciable. Finally the amount of sand coming into t

Digitized by Google

each seemed to decrease, and by the action of the current, aided by dredging, the channel rapidly resumed a normal condition.

The fluctuations in the depth and width of this channel, from month to month during the year, may be known from the following table:

Tabulated statement regarding the minimum depths and widths of channel through the jetties, in separate reaches of 2,000 feet each, according to surveys made monthly during the fiscal year ending June 30, 1891.

Date.	Distance from East Point, in feet.								
	0–2,000.			2,000–4,000.			4,000–6,000.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.
1890.									
June	32.0	340	170	33.5	350	240	33.0	310	220
July	32.4	350	120	33.4	330	240	34.0	330	210
August	32.0	330	110	33.0	340	230	33.0	300	200
September	30.5	340	80	31.4	350	220	33.0	320	230
October	32.0	320	130	31.0	330	220	31.0	270	120
November	30.6	300	50	31.2	310	60	30.6	260	80
December	31.5	310	60	31.2	300	60	31.0	240	80
1891.									
January	31.0	310	70	31.0	290	100	31.2	230	100
February	31.7	250	110	31.0	330	210	31.4	280	160
March	32.0	270	170	34.3	340	220	36.4	290	200
April	*30.5	240	50	32.0	360	60	36.5	300	230
May	*30.3	340	120	*32.0	360	200	32.0	310	200
June	33.0	350	150	31.1	360	220	32.0	300	150

Date.	Distance from East Point, in feet.								
	6,000–8,000.			8,000–10,000.			10,000–12,000.		
	Least depth.	Least width for—		Least depth.	Least width for—		Least depth.	Least width for—	
		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.		26-foot depth.	30-foot depth.
1890.									
June	34.0	250	210	39.8	270	200	35.0	250	150
July	34.0	250	210	39.0	290	230	37.0	260	160
August	32.7	260	190	35.0	260	200	34.0	240	130
September	33.0	240	200	35.0	250	180	33.0	230	130
October	30.5	240	120	34.0	240	150	32.8	220	120
November	30.6	240	40	34.0	260	150	33.0	220	140
December	30.7	230	70	32.3	220	90	33.5	200	130
1891.									
January	32.2	230	90	32.3	220	110	32.5	220	110
February	32.5	230	190	35.2	240	170	32.7	240	190
March	37.5	260	190	36.0	250	190	34.6	250	220
April	39.0	260	200	36.4	260	170	34.2	260	210
May	35.0	260	180	36.0	270	180	34.0	270	200
June	34.7	260	200	37.0	270	200	35.0	270	200

* Central depth less than 30 feet from April 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.

Beyond the ends of the jetties, and on a direct course from them to sea, the depth of channel varied during the year from 26 to 31 feet, the latter depth obtaining only during the month of March. The present depth of this channel is 27.4 feet, and the width of the 26-foot channel is 480 feet.

The channel turning to the eastward varied but little during the year; its depth is now 32 feet, the 26-foot channel being 480 feet wide, and the 30-foot channel 130 feet wide.

The following table gives the depths through the jetties from month to month during the past 16 years:

Digitized by Google

Table giving the depths of water through the jetties at various dates.

Date.	Distances from East Point, in feet.					
	0 to 2,000.	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1875—June	22.5	18.7	16.7	10.2	9.7	9.
1876—May	23.3	20.3	22.0	21.0	17.1	15.
August	23.5	19.6	21.0	23.5	23.0	19.
November	22.0	20.3	21.1	21.2	21.1	20.
1877—March	24.1	21.1	23.2	22.0	21.2	20.
July	24.9	24.0	26.0	23.8	23.5	20.
October 25 to December 14	26.3	24.4	28.5	24.2	22.0	23.
1878—March	26.0	25.9	35.5	25.4	24.3	23.
December	28.4	26.4	35.7	27.1	25.3	23.
1879—March	28.6	27.5	43.4	27.0	27.0	27.
June	27.5	28.4	47.7	29.2	29.2	28.
July	30.5	30.7	.....	31.0	30.7	30.
December	31.0	31.0	48.3	31.7	31.3	30.
1880—June	31.0	32.5	47.8	31.4	35.1	32.
July	30.5	31.0	44.0	30.8	31.5	30.
August	30.5	30.4	46.0	32.0	32.0	30.
September	30.7	31.0	44.4	30.6	32.0	31.
October	31.0	31.5	41.0	30.3	31.0	30.
November	30.6	31.0	40.3	30.8	30.9	30.
December	30.9	30.6	43.0	30.8	31.0	30.
1881—January	30.5	30.4	41.9	33.8	30.7	30.
February	30.4	30.2	41.6	32.0	31.0	30.
March	31.5	31.2	41.3	32.0	32.0	30.
April	30.4	30.0	43.0	33.0	33.0	30.
May	30.2	30.5	42.7	32.6	30.5	31.
June	30.0	30.5	43.8	32.0	31.7	31.
July	31.0	32.0	42.5	33.5	33.0	32.
August	30.1	32.0	37.6	32.0	31.0	30.
October	30.2	30.3	38.3	31.4	31.2	30.
November	30.8	31.8	39.2	30.4	30.0	30.
December	30.2	32.8	39.4	30.8	30.2	30.
1882—January	30.5	30.4	41.3	31.1	30.2	30.
February	31.8	36.0	39.7	30.5	30.8	30.
March	31.2	30.6	39.2	30.8	31.6	32.
April	31.7	32.6	39.6	30.5	30.3	33.
May	30.5	32.5	39.4	31.0	31.3	31.
June	30.8	35.5	39.0	31.2	31.3	31.
July	30.0	32.7	38.7	30.6	31.3	31.
August	30.3	32.2	38.1	31.8	31.8	30.
September	30.1	31.5	38.3	31.9	30.8	30.
October	30.0	31.0	37.1	31.0	31.4	31.
November	30.0	32.0	38.1	21.5	31.2	31.
December	31.0	31.0	37.0	31.2	31.0	30.
1883—January	31.0	31.0	35.2	30.2	30.1	30.
February	31.2	31.2	36.0	30.5	30.0	30.
March	32.3	32.6	45.7	31.5	30.3	30.
April	33.7	35.0	44.0	32.2	30.0	39.
May	33.2	36.3	46.0	32.3	30.3	32.
June	32.5	34.2	45.0	33.4	31.0	33.
July	33.8	34.9	44.0	32.0	31.5	31.
August	32.1	38.2	48.0	33.4	33.4	32.
September	33.4	34.3	46.0	32.3	32.3	30.
October	32.7	34.1	41.5	32.0	32.0	30.
November	31.0	33.8	43.8	34.5	31.5	31.
December	30.5	32.6	43.0	31.6	31.6	30.
1884—January	31.2	32.2	39.2	32.7	31.8	30.
February	32.0	31.5	41.3	31.6	31.0	30.
March	35.7	39.5	41.6	34.0	33.8	38.
April	35.3	37.3	41.5	31.7	32.7	35.
May	34.9	35.8	42.3	34.3	35.1	33.
June	35.0	35.8	41.1	34.0	35.0	35.
August	31.9	35.8	41.9	33.9	35.0	32.
September	32.0	34.0	39.0	33.1	33.7	33.
October	31.1	33.4	38.6	32.6	32.6	32.
November	32.8	32.8	37.2	32.2	32.4	30.
December	31.6	32.6	37.1	31.1	31.5	31.
1885—January	36.7	36.4	36.9	33.1	34.6	32.
February	41.7	36.3	35.7	30.5	34.1	36.
March	35.5	36.0	36.1	31.0	31.7	35.
April	36.0	35.5	37.0	32.0	32.6	32.
May	36.7	35.0	35.6	31.5	33.5	31.
June	34.7	33.7	35.7	32.8	32.8	31.
July	36.3	33.1	36.5	33.7	33.6	31.
August	36.5	35.6	37.6	33.0	32.6	31.
September	35.3	33.3	35.2	32.2	30.7	31.
October	33.8	33.7	35.8	31.3	30.4	30.
November	32.7	32.8	35.1	30.8	30.6	30.
December	33.0	32.2	34.2	30.9	30.5	30.
1886—January	33.6	32.5	33.0	30.2	30.2	28.
February	32.8	32.8	34.1	31.3	30.9	30.
March	32.8	35.8	34.0	35.0	33.1	32.

Digitized by Google

Table giving the depths of water through the jetties at various dates—Continued.

Date.	Distances from East Point, in feet.					
	0 to 2,000	2,000 to 4,000.	4,000 to 6,000.	6,000 to 8,000.	8,000 to 10,000.	10,000 to 12,000.
1886—April	35.4	34.5	34.5	33.7	33.7	31.0
May	35.9	35.6	34.2	31.0	36.0	34.4
June	33.2	35.2	33.4	33.2	34.5	36.5
July	36.7	36.7	36.2	32.8	33.7	37.0
August	35.0	36.3	35.7	34.8	33.8	34.7
September	34.5	35.6	34.6	33.7	33.6	33.0
October	35.0	36.2	34.4	33.0	34.1	33.0
November	34.5	35.6	34.8	32.9	33.0	33.5
December	34.0	35.0	35.3	33.6	32.6	33.0
1887—January	33.6	34.0	33.3	32.3	32.7	33.4
February	36.4	34.4	35.4	31.3	34.1	32.4
March	35.5	35.5	33.6	35.5	35.5	33.8
April	33.8	37.0	33.7	31.0	34.8	35.5
May	39.4	35.3	37.1	31.2	34.2	33.1
June	39.0	35.4	37.5	32.3	34.1	35.2
July	39.0	36.4	35.8	34.0	33.0	34.0
August	35.7	34.6	34.7	33.6	31.6	32.7
September	36.0	34.0	35.0	35.0	32.7	32.2
October	36.2	34.2	34.3	32.1	32.2	31.8
November	35.9	32.9	33.8	30.7	31.8	31.2
December	34.7	32.7	33.9	30.9	31.7	31.8
1888—January	35.6	32.5	33.7	30.5	31.5	32.2
February	34.3	32.4	32.5	31.0	31.0	32.0
March	34.0	33.0	32.6	30.5	31.3	30.9
April	36.3	34.8	33.8	31.0	35.0	31.4
May	35.2	35.2	34.3	31.6	33.6	33.0
June	32.0	33.0	33.0	31.4	35.5	33.2
July	34.2	34.0	33.8	31.0	31.9	33.6
August	33.7	33.7	33.7	31.2	31.2	33.2
September	32.7	32.7	32.8	30.8	31.0	32.0
October	33.3	33.3	32.3	30.6	30.4	30.4
November	31.8	32.8	31.7	30.6	30.6	30.8
December	31.4	32.4	31.6	30.3	*29.2	30.7
1889—January	31.0	31.3	30.6	30.3	31.0	30.9
February	32.4	32.5	31.8	32.8	31.0	32.5
March	30.2	32.2	30.4	32.3	31.8	31.6
April	30.8	32.1	31.2	32.8	31.8	30.6
May	30.8	32.0	30.7	32.6	31.2	30.8
June	30.4	32.2	31.3	31.5	31.0	30.8
July	30.3	31.0	31.0	32.4	31.3	31.0
August	31.7	31.4	31.5	31.6	31.4	31.0
September	30.9	31.3	31.2	31.0	31.1	.....
October	31.6	31.0	31.2	31.0	31.7	† 29.6
November	31.0	31.2	31.2	31.0	31.3	31.4
December	30.8	31.0	31.2	31.0	31.7	31.2
1890—January	30.8	30.8	31.2	30.6	31.0	31.0
February	31.7	30.7	31.5	32.6	34.4	33.0
March	36.4	33.2	34.0	34.0	34.0	33.6
April	33.4	36.0	35.0	35.0	38.7	34.5
May	32.0	34.0	34.0	36.0	39.0	34.0
June	32.0	33.5	33.0	34.0	39.8	35.0
July	32.4	33.4	34.0	34.0	39.0	37.0
August	32.0	33.0	33.0	32.7	35.0	34.0
September	30.5	31.4	33.0	33.0	35.0	33.0
October	32.0	31.0	31.0	30.5	34.0	32.8
November	30.6	31.2	30.6	30.6	34.0	33.0
December	31.5	31.2	31.0	30.7	32.3	33.5
1891—January	31.0	31.0	31.2	32.2	32.3	32.5
February	31.7	31.0	31.4	32.5	35.2	32.7
March	32.0	34.3	36.4	37.5	36.0	34.6
April	‡30.5	32.0	36.5	39.0	36.4	34.2
May	‡30.3	‡32.0	32.0	35.0	36.0	34.0
June	33.0	31.1	32.0	34.7	37.0	35.0

* From December 28, 1888, to January 4, 1889, inclusive.
† From October 1 to October 5, inclusive.
‡ Depth less than 30 feet from April 25 to May 6, both dates inclusive, and varied from 27.5 to 29.4 feet.

SURVEY BEYOND THE ENDS OF THE JETTIES.

The chart of this survey is No. 2. The deductions which have been made from similar surveys since 1876 furnish data on the most interesting and important subject connected with Mississippi jetties.

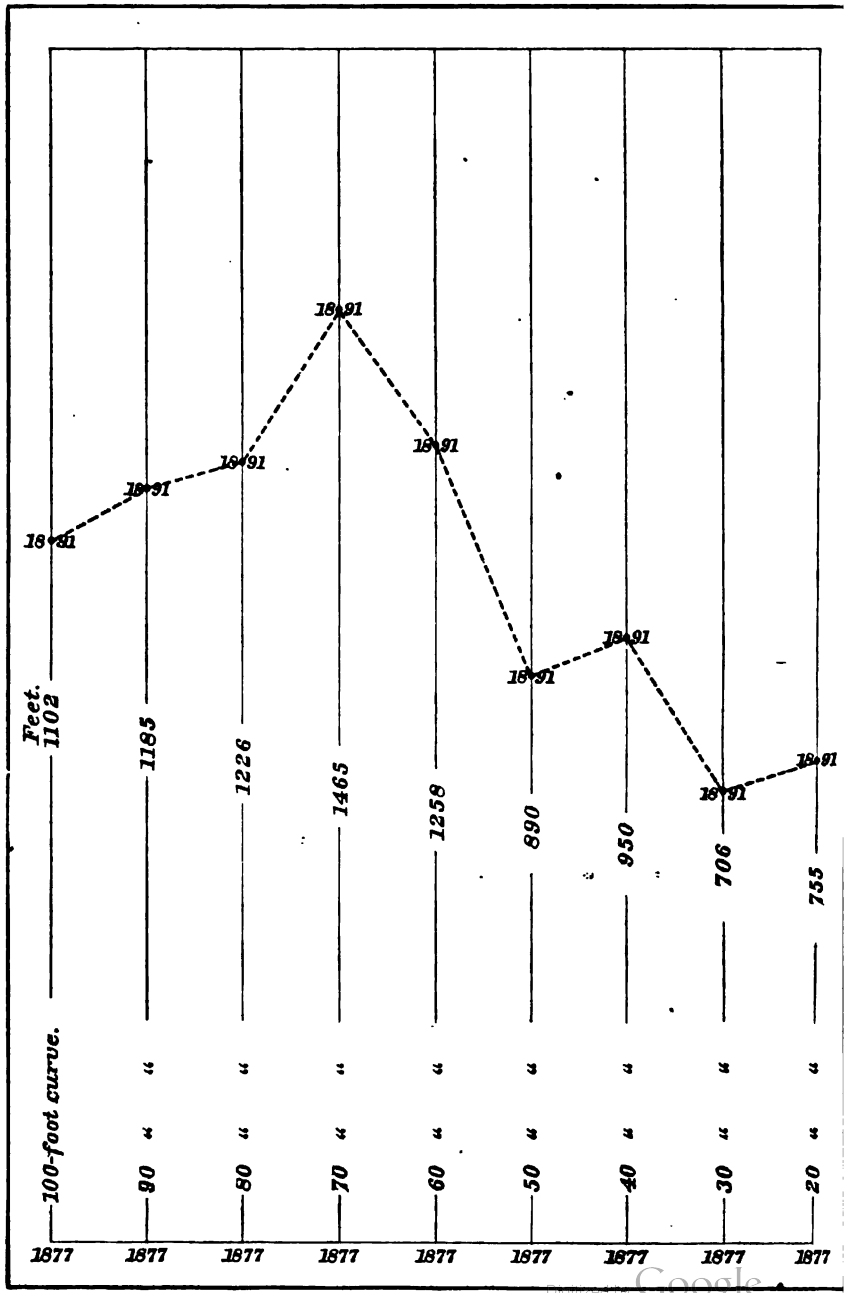
The area sounded contains a fraction more than 2 square miles, 1¼ square miles of which are subdivided into 21 lesser areas, and the mean depth of each division, and finally of the whole area, is obtained and compared with results similarly obtained for previous years. By this means we locate the areas of greatest or least change.

Digitized by Google

Another determination is then made by measuring ordinates 100 feet apart to ea curve designating depths, and the means of these when compared with similar ea lier results gives the distance that each curve has advanced or receded, and cons quently indicates whether the area has shoaled or deepened.

From chart No. 7 it will be seen that all except the 100-foot curve advanced du ing the year, that one showing but a slight recession of 80 feet. The 80-foot cur shows the least advance of 77 feet, and the 60-foot curve the greatest of 391 feet.

The following diagram gives the distance that each curve has advanced since 187 the 30-foot curve showing the least advance of 706 feet, and the 70-foot curve t greatest of 1,465 feet.



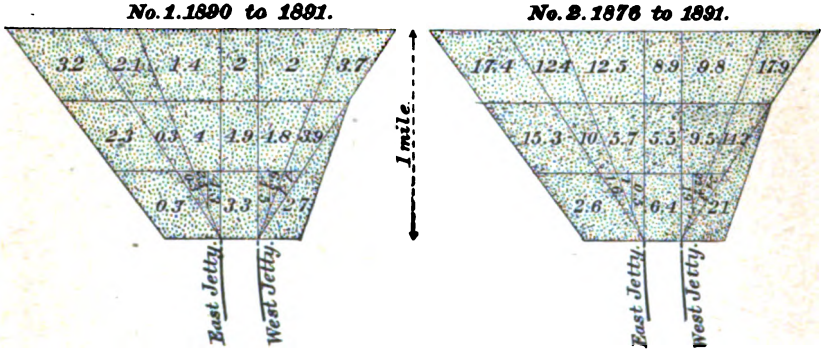
Digitized by Google

The foregoing determinations indicate a decided shoaling during the year, and since 1876 the mean vertical height of which over the area of 1¼ square miles for each year from 1876 to 1891 is as follows:

Years.		Mean change over whole area.		Years.		Mean change over whole area.	
From—	To—	Deepened—	Shoaled—	From—	To—	Deepened—	Shoaled—
1876	1877	.....	0.40	1884	1885	1.16	.....
1877	1878	1.80	.....	1885	1886	.....	0.12
1878	1879	.....	2.56	1886	1887	.....	1.38
1879	1880	0.12	.....	1887	1888	.....	0.31
1880	1881	.....	2.38	1888	1889	1.23	.....
1881	1882	.....	1.30	1889	1890	.....	1.11
1882	1883	0.04	.....	1890	1891	.....	2.70
1883	1884	.....	3.61				
				1876	1891	.....	11.52

The following diagrams furnish in detail the results of determinations to ascertain the change over each of twenty-one lesser areas into which the area containing 1¼ square miles is divided, and the results show the distribution of the shoaling over that area.

No. 1 results from comparing the mean depths for 1890 with those for 1891, and No. 2 compares those for 1876 with those for 1891. The figures in each division express in feet and tenths of a foot the vertical height of the shoaling or deepening, shaded areas having shoaled and blank areas deepened.



NAVIGATION OF THE CHANNEL.

At times during the months of April and May, while volumes of sand were moving through the pass, vessels were reported as having touched the bottom at points from one-half to 2¼ miles below Grand Bayou. I have known of a few cases, but the vessels were afloat before I could get to them and determine their location. The channel was often carefully sounded, and more than the required depth of 26 feet always obtained.

CONCLUSION.

During the year, as for many years past, I was efficiently assisted by Recorder G. W. Lawes.

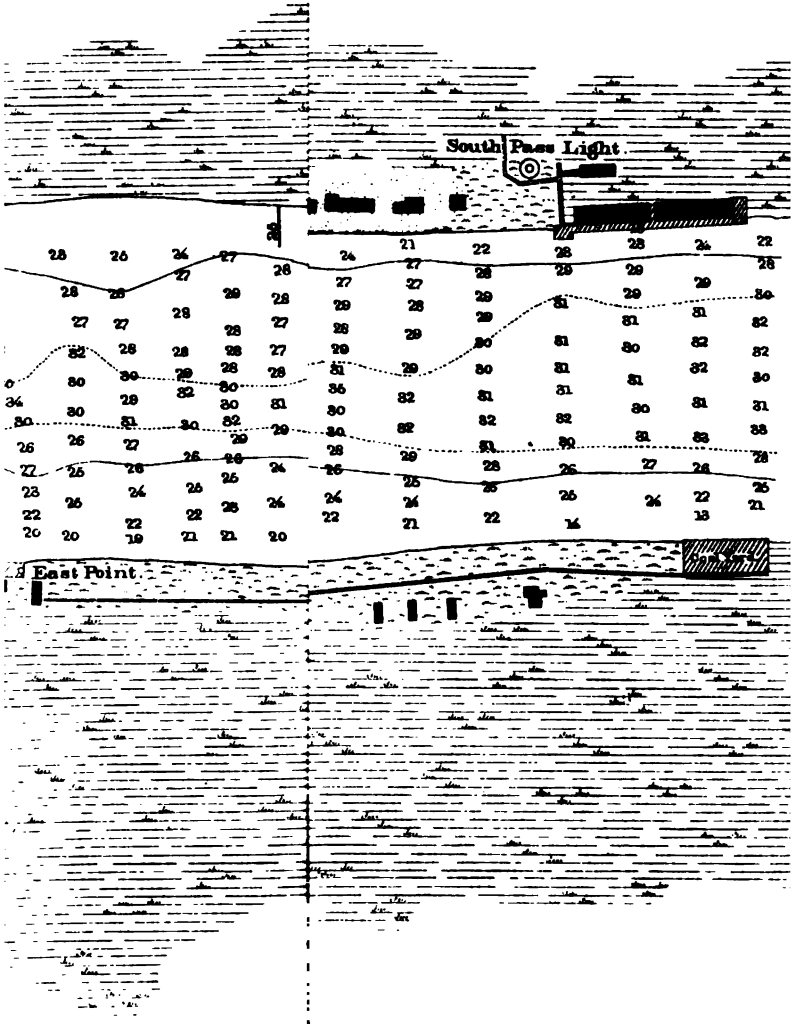
Very respectfully, your obedient servant,

C. DONOVAN,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

Digitized by Google

Digitized by Google



r the year ending June 30, 1881.

James B. Quinn

Major of Engineers, U. S. A.

Eng

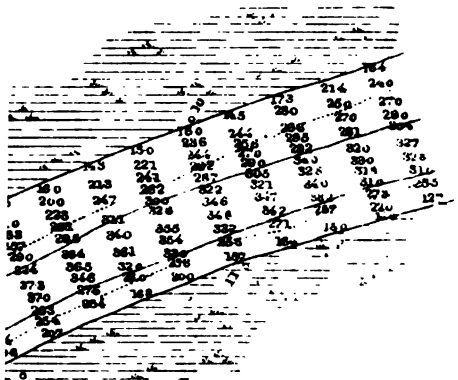
Digitized by Google

Digitized by Google

Eng 91

Digitized by Google

Digitized by Google

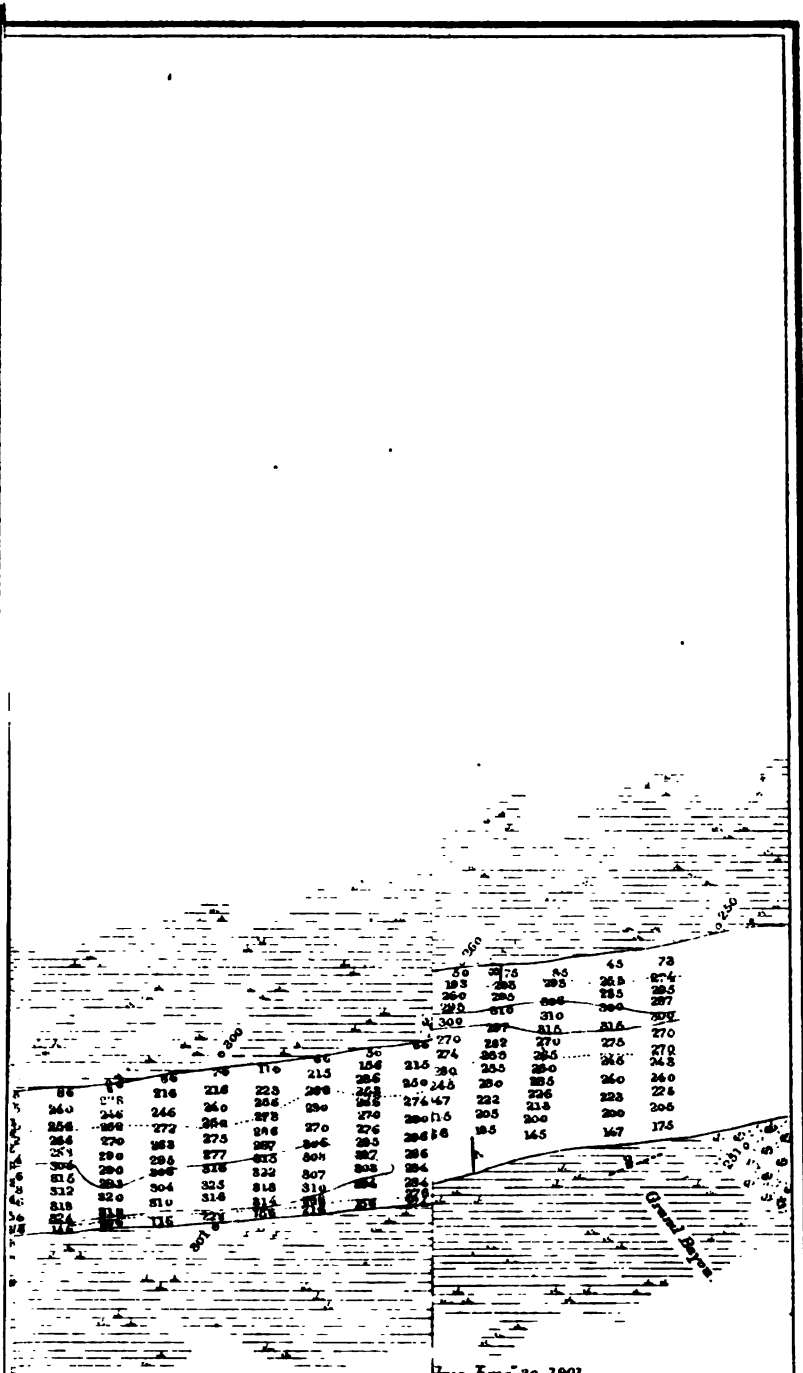


report for the year ending June 30, 1891.

James B. Quinn
Major of Engineers, U. S. A.

Digitized by Google

Digitized by Google



ing June 30, 1881.

B. Bruce

Major of Engineers, U. S. A.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

To accompany report of June 30, 1881.

D. C. Houston
Major of Engineers, U. S. A.

Fig 91

Digitized by Google

Digitized by Google

Eng 91

Digitized by Google

Digitized by Google

APPENDIX S.

IMPROVEMENT OF CERTAIN STREAMS IN LOUISIANA, AND OF HARBOR AT SABINE PASS, SABINE RIVER AND NECHES RIVER, TEXAS.

REPORT OF MAJOR JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chefuncte [Tchefuncte] River and Bogue Falia, Louisiana.
2. Tickfaw River and its tributaries, Louisiana.
3. Amite River and Bayou Manchac, Louisiana.
4. Bayou La Fourche, Louisiana.
5. Bayou Terrebonne, Louisiana.
6. Bayou Plaquemine, Louisiana.
7. Bayou Courtableau, Louisiana.
8. Bayou Teche, Louisiana.
9. Mouth and passes of Calcasieu River, Louisiana.
10. Harbor at Sabine Pass, Texas.
11. Sabine River, Texas.
12. Neches River, Texas.
13. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS AND SURVEY.

14. Bayou Carlin, Louisiana.
15. Shoals on Lake Pontchartrain, Louisiana, near the Rigolets, known as the "Middle Ground," with a view of dredging a channel 10 feet deep and revetting sides of the same.
16. Bayou Chevreuil and Bayou Tigre, Louisiana, from Lake Des Allemands to points near Vacherie, Chigby, and Malagay settlements in St. James Parish, for removal of bars and other obstructions to navigation.
17. Bayou Terrebonne, Louisiana, from Houma to Thibodeaux.
18. Bayou Black, to connect with Terrebonne, Louisiana.
19. Berwick Bay, Louisiana, to the Gulf, with a view of obtaining a deeper channel.
20. Bayou Cocodrie, in St. Landry Parish, Louisiana.
21. Bayou Black, Louisiana, for connection between Calcasieu Lake and Sabine Lake.
22. Bayou Teche, Louisiana, from St. Martinsville to Port Barre.
23. Bayou Des Glaises, Louisiana, with a view of clearing the stream of obstructions from the Atchafalaya River to Cottonport.
24. Bayou Vermillion, bay and passes, Louisiana.
25. Mermenton River, Louisiana, including its tributaries and course through Lake Arthur and Grand Lake to the Gulf of Mexico.

Digitized by Google

OFFICE UNITED STATES ENGINEER,
New Orleans, La., July 9, 189

GENERAL: I have the honor to transmit herewith annual reports u works of river and harbor improvement at present in my charge for fiscal year ending June 30, 1891.

* * * * * * *

Very respectfully, your obedient servant,

JAMES B. QUINN,
Major, Corps of Engineer

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

S I. :

IMPROVEMENT OF CHEFUNCTE [TCHEFUNCTE] RIVER AND BO FALIA, LOUISIANA.

The project for the improvement of this river was made in 1880 : contemplated the removal of overhanging trees, logs, etc., in the c nel and the dredging of the bar at its mouth.

The first appropriation of $1,500 was made March 3, 1881, a second one of $1,500 in August, 1882. With these two appropria the obstructions below Covington were removed, and part of th expended balance was used for the construction of a working plan improving the bar at the mouth and part for the construction of a b water extending 820 feet into the lake.

The third appropriation for this work, $2,500 made August 5, 1 was expended in improving Bogue Falia between Old Landing and ington by cutting a channel 5 feet in depth and 30 to 60 feet in w through the bars between these places.

The original estimate for improving this river was $5,460 the gr portion of which was for dredging the bar at the mouth.

It was thought, however, that a dredged channel over this bar c not be maintained without protecting works, which would cost co erably more than the dredging. Major Stickney, who had this in charge, caused a reëxamination to be made in 1884, and in his r in the Annual Report of the Chief of Engineers for 1884, vol. II. 1269, he reports the river in good order, except the bar at its m and suggests as a method for improving this to build a jetty or b water 2,500 feet long across the bar into the comparatively deep of Lake Pontchartrain, and then to dredge the channel through bar, in the hope that the jetty would prevent, or at all events gr retard, the refilling of the cut with sand.

In 1890 $1,000 was appropriated for continuing the improveme this river and bayou.

For the expenditure of this money the approved project is to us Government plant now used in the Amite River to remove the s and impending trees and similar obstructions in the channels.

Nothing was done during the year, but the work will be continue soon as the Government plant is available.

It will cost $1,000 annually to keep this river and bayou in each year.

Digitized by Google

Money statement.

Amount appropriated by act approved September 19, 1890	$1,000.00
July 1, 1891, balance unexpended	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,000.00

COMMERCIAL STATISTICS.

Aggregate number of trips out of river	777
Aggregate tonnage of same	18,037

Articles.	June 1, 1889, to May 31, 1890.		June 1, 1890, to May 31, 1891.	
	Tonnage.	Value.	Tonnage.	Value.
Lumber	8,834	$66,255	11,202	$56,010
Shingles	.....	.....	3	60
Staves	347	740	1,802	7,725
Brick	1,372	4,690	1,577	5,679
Sand	10,056	14,366	11,499	10,249
Wood	6,838	13,676	8,388	26,845
Charcoal	.....	.....	10,220	97,500
Miscellaneous freight	.....	.....	130	3,000
Cotton	356	73,550	.....	.....
Total	27,803	173,283	45,521	201,061

S 2.

IMPROVEMENT OF TICKFAW RIVER AND ITS TRIBUTARIES, LOUISIANA.

This work was commenced in 1879 by an examination authorized by Congress. The estimated cost of the improvement was $10,230, and the project was to clean out this stream as well as its navigable branches, the Natalbany, Blood, and Ponchatoula, by removing such obstacles to navigation as snags, logs, stumps, and overhanging trees.

In 1881 Congress appropriated $2,000 to commence the work. Work was done by contract in 1882, and 16 miles of Tickfaw River were cleaned out.

In 1882 $2,000 more was appropriated. This was expended partly in building plant, and the work of cleaning out the stream was done with this plant and hired labor. The result was a good navigable channel 9 miles above the previous head of navigation on the Tickfaw.

In 1886 Congress appropriated $2,000 more, the funds to be available for cleaning out the navigable branches of the Tickfaw.

In the latter part of 1886 and early part of 1887 work was resumed with the Government plant and hired labor, and the branches cleared to the head of navigation.

In 1888 Congress appropriated $1,000 for the Tickfaw and its navigable tributaries. The latter being in good condition, the Government snagging plant commenced on the river itself early in May, 1889, removing the obstructions that had reformed since 1887, and worked upstream to within 1 mile of the Chapman Place, where work ceased, the appropriation being exhausted.

The improvement is not permanent, since logs and snags find their way into the navigable channel and form obstructions which have to be removed. In 1890 $1,000 was appropriated for the continuance of im-

Digitized by Google

provement, but nothing has been done yet, the project providing that the work be done with the Government plant, which is still employed on the Amite River.

The character of the improvement is such that about $1,000 will be required annually to keep the navigable channel in condition.

Money statement.

Amount appropriated by act approved September 19, 1890	$1,000.00
July 1, 1891, balance unexpended	1,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	1,000.00

COMMERCIAL STATISTICS.

Commerce of Tickfaw River from June 1, 1890, to May 31, 1891.

Six arrivals (schooners); gross tonnage, 114 tons.

Commodities.	Tons.	Value.
Wood	116	$65
Lumber	185	1,036
Total	301	2,401

S 3.

IMPROVEMENT OF AMITE RIVER AND BAYOU MANCHAC, LOUISIANA.

The original project for the improvement of this river was adopted in 1880, the result desired being a 5-foot depth of channel as far upstream as appropriations would permit, the main portion of the work to be done above the mouth of the Bayou Manchac.

In 1880 $8,000 was appropriated for this work, and in 1881 $5,000 more.

In 1883, owing to the inefficient manner in which the work was done by contract, the project was amended so as to provide for the removal of obstructions below the Manchac by the Government plant and hired labor, and resulted in a satisfactory improvement of about 8 miles of the river.

In 1886, under an appropriation of $2,000, work with Government plant and hired labor was resumed, and the logs and snags removed from about 5 miles of river below mouth of Bayou Manchac, leaving the Amite River in good navigable condition.

In 1888 $5,000 was appropriated with the stipulation that half of this sum might be used in improving Bayou Manchac, and in November, 1888, work with the Government plant and hired labor was commenced in Bayou Manchac, working up from its mouth to Hereford Landing, leaving the Manchac in good condition up to that point.

The outfit then returned to the Amite River, and from it removed the obstructions formed by snags, stumps, and impending trees.

In 1890 $3,800 was appropriated for the completion of the old project, the money, however, to be applied to the Amite or Manchac in such

Digitized by Google

proportions as the engineers might deem best. Work was resumed in October, 1890, with the Government plant and hired labor, at Hope Villa, on the Manchac, and the bayou cleaned up for a distance of about 3 miles, when the outfit turned back, and, commencing at Wards Creek, worked down stream to the Amite River.

High water and sickness of the men caused considerable delay, and the progress of the work has been slow and unsatisfactory. It does not appear that the improvement can be permanent, since logs and stumps are continually getting into the Bayou and Amite River, forming snags and obstructions that will require removal from time to time to preserve the navigation.

About $2,500 will suffice to keep this river and bayou in navigable condition for the ensuing fiscal year.

Money statement.

July 1, 1890, balance unexpended	$514.04
Amount appropriated by act approved September 19, 1890	3,800.00
	4,314.04
June 30, 1891, amount expended during fiscal year	3,191.90
July 1, 1891, balance unexpended	1,122.14
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,500.00

COMMERCIAL STATISTICS.

Aggregate number of trips out of river	175
Aggregate tonnage of same	6,411

Articles.	June 1, 1890, to May 31, 1890.		June 1, 1890, to May 31, 1891.	
	Tonnage.	Value.	Tonnage.	Value.
Lumber	8,309	$52,065	7,751	$62,320
Shingles	428	8,568	380	5,985
Brick	634	2,330	216	782
Wood	14,272	28,544	1,525	4,115
Staves	58,218	66,560	1,512	5,850
Laths	.....	.....	156	4,064
Sand	1,582	2,260	4,916	4,214
Cotton and seed	952	131,640	1,221	205,728
Miscellaneous freight	.....	.....	165	7,405
	84,295	291,967	17,792	300,963

S 4.

IMPROVEMENT OF BAYOU LA FOURCHE, LOUISIANA.

The original project for this work was approved in 1879, and had for its object the removal from the bayou the obstructions to navigation, which consisted of snags, wrecks, raft heaps, and impending trees. Under this project work was carried on from 1881 till 1883, when the plant was laid up at Lockport after clearing the bayou a distance of 30 miles below Lockport.

In 1884 a project was approved for continuing the snagging operations

Digitized by Google

on down beyond the point where operations had ceased in 1883, and accordingly work was resumed in September, 1884, and continued to January, 1885, when work was suspended on account of high water. Subsequently the plant was removed to other places.

Beyond surveys and examinations, nothing further was done until 1888, when Congress appropriated for "improving Bayou La Fourche, Louisiana, pursuant to the project of Lieut. O. T. Crosby, Corps of Engineers, dated June 11, 1886, $50,000, including immediate dredging to secure low-water navigation."

During 8 months of the year, when the Mississippi River is high, Bayou La Fourche is navigable by the largest steamboats; but during extreme low water navigation is sometimes entirely suspended for flat-boats drawing over 2 feet of water.

The project of Lieutenant Crosby's referred to in the foregoing act was to place a lock at the Mississippi River end of the bayou, converting the bayou into a slack water stream, and to then dredge a channel 75 feet wide and 5 feet deep at mean low water of the Gulf throughout its length.

The act also provided for immediate dredging, and since the bar at the river end of the bayou had shut out navigation in 1887, it was proposed to dredge a channel through this bar, the channel to have a depth of 4 feet below mean low water of the Gulf, and a width of 60 feet. This dredging was done by contract and admitted sufficient water to the bayou to reëstablish flat-boat navigation, which had been suspended a day or two while the cut was being made.

It having been ascertained that about 150,000 cubic yards of material would have to be dredged from the bayou to secure 2 feet depth for flat-boat navigation, on June 10, 1889, bids were opened for dredging this amount, but the price bid was deemed too high and the bid was rejected. Dredging was then begun by a hired dredge and continued until high water interfered.

The channel had been carried a distance of about 2 miles from the mouth and had a depth of 2 to 3 feet at mean low water of the Gulf. Upon commencing this dredging it was found that the channel through the bar at the head of the bayou had shoaled so as to require redredging and much of the channel work had to be gone over several times owing to the caving of the sides of the cut. On September 15, 1890, dredging was resumed. The dredge had, as formerly, to reopen the cut through the bar at the head of the bayou and redredge much of the channel previously gone over.

The work progressed favorably until high water in January, 1891, caused its suspension.

Work will be resumed as soon as the high water subsides.

The improvement by dredging is a slow and unsatisfactory way, since the silting up of the dredged channel takes place with the recurrence of high water each year. The construction of a lock at the head of the bayou will almost entirely overcome this difficulty and render the navigation of the bayou safe and certain under all conditions of tide in the Mississippi River.

The cost of a lock at Donaldsonville, La., was estimated by Lieutenant Crosby to be about $450,000. With this lock completed whatever dredging was done in the bayou would be practically permanent and a moderate annual outlay would maintain satisfactory navigation hardly possible to secure with any amount of money under the present conditions.

Digitized by Google

Money statement.

July 1, 1890, balance unexpended	$35,407.49
Amount appropriated by act approved September 19, 1890	50,000.00
	85,407.49
June 30, 1891, amount expended during fiscal year	12,690.93
July 1, 1891, balance unexpended	72,716.56
Amount (estimated) required for completion of existing project	400,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Number of vessels, 1890-'91	9
Total registered tonnage of same, net	2,738
Aggregate number of trips out of bayou	372
Aggregate tonnage of same	151,149

Articles.	June 1, 1889, to May 31, 1890.		June 1, 1890, to May 31, 1891.	
	Tonnage.	Value.	Tonnage.	Value.
Sugar	26,660	$2,621,598	44,832	$3,290,481
Molasses	19,780	358,320	31,984	968,000
Rice	10,050	353,112	8,310	326,736
Potatoes and onions	4,078	134,868	4,709	151,447
Eggs			111	2,505
Moss	178	10,680	205	12,270
Pecans			77	5,190
Miscellaneous freight		36,304	475	35,466
Total	60,746	3,514,882	90,703	4,792,095
INWARD FREIGHT.				
Miscellaneous freight	75,000	1,980,000	54,420	3,194,730
Coal	65,000	214,500	72,150	257,400
Total	140,000	2,194,500	126,570	3,452,130

S 5.

IMPROVEMENT OF BAYOU TERREBONNE, LOUISIANA.

Previous to the commencement of the improvement of the Bayou Terrebonne it was but little better than a drainage ditch in places.

In 1880 an appropriation of $10,000 was made for the improvement of this bayou, and the work of dredging was commenced in 1880 and continued until December 17, 1887, when the channel was completed to the railroad depot at Houma, where a turning basin was dug.

The improvement enables planters on the bayou to float their produce to Houma to the railroad or else ship by boat direct to New Orleans by way of connecting bayous and canals.

It is doubtful if the improvement can be made permanent, as more or less silt finds its way into the bayou, causing shoals to form which will require removal from time to time.

During the past year no work has been done and it is not believed that more work will be required during the ensuing year than can be secured with the funds remaining available.

The estimated cost of the improvement was $38,800. The completion of the project has cost $35,808, leaving $2,992 for repairs and incidental expenses.

Digitized by Google

Having been unable to obtain commercial statistics for the past year those for the previous year are appended.

Money statement.

July 1, 1890, balance unexpended	$2, 99[illegible]
June 30, 1891, amount expended during fiscal year	[illegible]
July 1, 1891, balance unexpended	2, 99[illegible]

COMMERCIAL STATISTICS.

Number of vessels, 1889–'90	[illegible]
Total registered tonnage of same	[illegible]
Aggregate number of trips out of river	[illegible]
Aggregate tonnage of same	[illegible]

Articles.		June 1, 1888, to May 31, 1889.		June 1, 1889, to May 31, 1890.	
		Quantity.	Value.	Quantity.	Value
Sugar	bbls.	11, 623	$209, 214	8, 745	$15[illegible]
Molasses	do	4, 443	35, 544	3, 586	2[illegible]
Rice	sacks	250	812	350	1[illegible]
Potatoes	do	258	516	350	[illegible]
Moss	bales	12	72	24	[illegible]
Total	tons	3, 076	.....	2, 394	.....
INWARD FREIGHT.					
Coal	tons	1, 000	5, 000	1, 500	[illegible]
Miscellaneous freight	do	1, 340	179, 000	1, 160	13[illegible]
Total	tons	5, 416	430, 158	5, 054	32[illegible]

S 6.

IMPROVEMENT OF BAYOU PLAQUEMINE, LOUISIANA.

Prior to 1867 or 1868 Bayou Plaquemine was navigated by the largest steamboats, but some time during the year mentioned the police jury of Plaquemine, without any apparent warrant of law, caused a dike to be built across this bayou shutting out the water of the Mississippi River.

Steamers which had used the Plaquemine route to Grand Lake and the Teche country were thereafter obliged to go by way of the mouth of Red River and the Atchafalaya to reach their districts and for some time past have been entirely cut off from communication by this round about way on account of the closing of the mouth of Red River at low water. The opening to navigation of this bayou is therefore of importance to the navigation of the Red, Black, Ouachita, and Atchafalaya rivers, and the bayous Tensas, Bartholomew, Maçon, Bœuf, Cypress, Teche, and Courtableau, the natural water transportation routes of a very fertile and very large area of rapidly improving country.

In 1885 a project for the improvement of this bayou, by building a lock to connect it with the Mississippi River and clearing out the channel so as to give a depth of 6 feet at mean Gulf low-water level, was presented. This improvement was estimated to cost $1,708,250.

In 1888 $100,000 was appropriated "for securing a navigable channel 60 feet wide and 6 feet in depth from deep water up to the Plaquemine Dike, and for securing the mouth of the bayou from further caving." As

Digitized by Google

there was no plant at the disposal of this office for the construction of dikes, etc., $75,000 of this appropriation was allotted for the construction of bank protections and turned over to the officer in charge of the fourth district of the Mississippi River in May, 1889.

With the remainder of the funds dredging was commenced June 4, 1889, at a point about 5 miles below the town of Plaquemine, the work being done with a dredge belonging to the United States and hired labor. This dredging was continued up to date with short interruptions due to high water.

Owing to the railroad bridge at Plaquemine not being a drawbridge, it has not been possible to continue the dredging up to the Plaquemine Dike as specified in the act of appropriation.

The project was accordingly modified so as to stop dredging when the railroad bridge was reached.

As soon as the bridge is reached, which will be very soon, the dredge will turn back and work down the bayou.

In 1890 $100,000 was appropriated for continuing the work of improvement of this stream; $40,000 was allotted to this office, the rest being allotted for bank protection as in the case of the preceding appropriation.

Under this last appropriation of $40,000 I presented a project for the commencement of work upon the lock at Plaquemine.

This project has not yet been approved.

*Money statement.**

July 1, 1890, balance unexpended	$53,605.44
Amount appropriated by act approved September 19, 1890	100,000.00
	153,605.44
June 30, 1891, amount expended during fiscal year	21,542.01
July 1, 1891, balance unexpended	132,063.43
Amount (estimated) required for completion of existing project	1,508,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

There was hauled by wagon to the Mississippi River for shipment to New Orleans, from June 1, 1890, to May 31, 1891, as follows:

Articles.	Tons.	Value.
Sugar	1,870	$132,600
Molasses	1,629	71,600
Moss	50	2,500
	3,549	206,700

The cypress logs cut into shingles, lath, and lumber by the 7 mills on Bayou Plaquemine amounted to 63,000,000 feet, or 141,750 tons; value, $504,000.

All of the logs were towed to the mills by steamers.

* This money statement includes that for securing mouth of Bayou Plaquemine from further caving (Appendix T 1).

Digitized by Google

S 7.

IMPROVEMENT OF BAYOU COURTABLEAU, LOUISIANA.

During the high water in the Atchafalaya River a bar forms in the mouth of this Bayou Courtableau, but upon the subsidence of the Atchafalaya the reflex water of the bayou causes some scour to take place on the bar.

Acting upon the supposition that if all the water carried by the Courtableau was concentrated upon the bar obstructing its mouth it would be removed, a project was approved in 1879 which had for its object the closing of all bayous flowing out of the Courtableau to the southward to prevent any escape of water by these lateral streams, and to construct locks and dams so as to make slackwater navigation; first, Port Barre, 17 miles upstream, and then to Washington, La., 11 miles farther up.

The preliminary estimate for the cost of this work was $40,000, which was afterwards increased to $78,500, and it was reported in the annual report of 1886 that the cost of masonry lock and dam would be $175,000.

In 1882 dams were built on the Big and Little Fordoche bayous, and timber was slashed into the smaller bayous so as to concentrate the flow of water over Little Devil Bar. The result was favorable, and 3 feet increased depth of water was obtained in 2 days.

It was reported that the swampers cut one of these dams afterwards and Little Devil Bar again shoaled up. In 1885 the cut dam was rebuilt and the other one repaired. A sudden rise caused one of these dams to break, but it was repaired, and during the following summer good results were hoped from the effect the two dams would produce.

In the summer of 1886 the Courtableau was exceptionally low, and Little Devil Bar was shoaler than ever. At its lowest stage a skiff could not be floated over the bar.

Lieutenant Crosby was sent to the Courtableau in September, 1886, to examine the stream prior to resuming work with the money appropriated the month previous.

From his report (Annual Report Chief of Engineers, 1887, p. 1376) it will be seen that the prospects of success, even should all the run-out bayous be closed, are anything but certain, yet the closure of two of the principal outlets in one season did produce an increase of depth of 3 feet. In view of this fact, and that the project called for the closure of these bayous, work of dam building was resumed in November, 1886.

Slight necessary repairs were made to the old dams in the Big and Little Fordoche, and a new dam was built in Bayou English.

Bayou Mamzelle was similarly closed, and the wings of the dam closing the Big Fordoche were repaired. At the time work ceased, early in November, the bar was cutting out rapidly, there being then a channel of from 3 to 5 feet deep, while when work began there was one of but a few inches in depth.

The new channel was then of no use, however, as the closure of Old River permitted no boats to enter the Atchafalaya from the Mississippi River.

The high water of 1888 formed the bar again, as usual, depositing sand to a depth of probably 6 or 8 feet over a length of 2 miles.

A personal examination was made in October, 1888, by Capt. W. L. Fisk, Corps of Engineers, during low water. He states he observed

Digitized by Google

that the preceding high water had cut around one end of each of the dams already built, but they had caused a sand bar to form at each, varying in height from 2 to 3 or 4 feet above the water in the Courtableau at the time of the examination, thus forcing all the water in the bayou to pass out into the Atchafalaya across Little Devil Bar, the head of which was then some 300 or 400 yards above the Little Fordoche. The volume of water, considerably greater than usual at low water, due to heavy local rains, was running with great velocity, and was moving a large quantity of sand, as could be plainly seen; but the depth at the shoalest point could not have been greater than 18 inches.

Had the bar been cut out to a suitable depth for navigation it is doubtful if it would have left sufficient water in the bayou above for purposes of navigation.

As soon as possible preparations were begun after high water in 1888 to repair the existing dams and to build others and for closing some of the remaining outlets, but before the snagging plant which was to be used in doing the work could be put in repair the water rose to such a height that nothing could be done.

The water having fallen sufficiently work was resumed on September 2, 1889. The broken dams in Bayous Mamzelle, English, and Fordoche were all repaired with piles and sheet piles, brush aprons placed above and below them, held down by sinking trees and earth, and left in good condition.

Bayous Big Cane and Little Cane, both small and of little importance, were obstructed by clashing trees into them, and the boats taken to Bayou Juramon on November 23 for work, but the water rose so rapidly the plant and lumber had to be taken to Washington, laid up in good shape, and the crew discharged November 30.

Beyond slight repairs to the derrick boat nothing was done during the fall of 1890, and since then high water has obstructed operations. As soon as the water falls sufficiently the repairs of the dams and closing of the runout bayous will be resumed.

As it is doubtful if the completion of the present project will permanently remove the bar at the mouth, it is believed that with the funds in hand sufficient can be accomplished during the ensuing year to demonstrate the advisability of continuing the method of improvement being pursued.

No money is asked for the next fiscal year.

Money statement.

July 1, 1890, balance unexpended	$1,089.39
Amount appropriated by act approved September 19, 1890	2,200.00
	3,289.39
June 30, 1891, amount expended during fiscal year	464.26
July 1, 1891, balance unexpended	2,825.13

Digitized by Google

COMMERCIAL STATISTICS.

Arrivals of vessels	6
Departures of vessels	6
Total registered tonnage of same	2,348
Aggregate number of trips out of river	132
Aggregate tonnage of same	70,030

Articles.	June 1, 1889, to May 31, 1890.		June 31, 1890, to May 31, 1891.	
	Tons.	Value.	Tons.	Value.
Sugar	1,800	$145,500	1,584	$128,040
Molasses	554	12,444	427	10,950
Rice	444	15,632	1,390	13,756
Cotton and cotton seed	15,296	2,454,690	13,460	2,160,135
Hides	31	1,920	21	1,690
Staves	536	2,446	412	2,152
Wood	3,306	7,552	2,909	6,646
Miscellaneous freight, eggs, and wool	.....	9,400	88	17,970
Total	21,967	2,649,584	20,291	2,341,339
Inward freight	14,000	1,980,000	12,327	1,576,005
Total	35,967	4,629,584	32,618	3,917,344

The above is the combined traffic of Bayous Courtableau and Des Glaizes, which can not be accurately separated, but probably about one-half belongs to each. The depreciation in tonnage and values is due to floods and crevasses of 1890–'91.

S 8.

IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

This bayou is navigated ordinarily by steamboats throughout the year.

Prior to 1886 navigation was obstructed by logs, snags, and impending trees, but money having been appropriated the stream was thoroughly cleared of such obstructions from Port Barre down. Since the completion of this work some further obstructions have found their way into the bayou, and in 1890 $5,000 was appropriated with which to accomplish their removal.

Under this appropriation it is proposed to remove the logs, snags, etc., by hired labor, using the Government plant now laid up on the Bayou Courtableau. Nothing has yet been done, on account of high water, but as soon as the water subsides sufficiently work will be commenced.

Money statement.

July 1, 1890, balance unexpended		$462.08
Amount appropriated by act approved September 19, 1890		5,000.00
		5,462.08
June 30, 1891, amount expended during fiscal year		40.24
July 1, 1891, balance unexpended		5,421.84

Digitized by Google

COMMERCIAL STATISTICS.

One steamboat, net tonnage 700 tons, made 28 trips from the Bayou Teche to New Orleans from June 1, 1890 to May 31, 1891, bringing cargo, viz:

Articles.	Tons.	Value.	Articles.	Tons.	Value.
Sugar	7,675	$607,938	Hides	100	$10,014
Molasses	4,010	121,790	Cotton and seed	742	79,814
Rice	78	3,362	Cotton-seed oil	181	11,360
Potatoes	85	3,571	Wood	2,374	6,785
Eggs	20	4,657	Sundry freight	60	3,100
Moss	40	2,005			
Pecans	5	630	Total	15,370	855,026

The up freights, such as provisions, grain, merchandise, machinery, fertilizers, cooperage, building material, etc. (estimated), amounted to 11,535 tons, value $860,000; a grand total of 26,905 tons; value $1,715,026.

S 9.

IMPROVEMENT OF MOUTH AND PASSES OF CALCASIEU RIVER, LOUISIANA.

In 1874, and again in 1882–'83, dredged channels were cut through the flats in Calcasieu Lake above Calcasieu Pass. The dredged channel was 8 feet deep and 70 feet wide by 7,500 feet long. The work was done by contract.

In 1885 this channel had again shoaled to a depth of 3½ feet and needed redredging, but by an unfortunate wording of the appropriation, funds in hand for "Improving Calcasieu River" could not be applied to this particular work. In 1886 this was remedied, and funds heretofore appropriated for Calcasieu River became available for both the pass and the river.

Contracts were made in 1886 for building two revetment walls of piles and planks, one on each side of the proposed cut, to be about 130 feet apart, each to be a mile or more in length, and between these to dredge a channel 100 feet in width and 6 feet in depth, the excavated material to be thrown outside the revetment walls. In addition to this another bar at the mouth of the Calcasieu River at the northern end of the lake was giving occasional trouble, and the same contract also required the excavation of a channel through this bar 100 feet wide by 6 feet in depth. Work was commenced on the revetments in the winter of 1886, but the weather was so severe that the contractor and several of his men died from sickness due to exposure on this work.

In the spring of 1887 work was resumed by the administrator of the contractor's estate, and the revetment nearly completed. At the date of the annual report for 1887 a dredge was expected to begin work within a few weeks, and actually arrived there about the middle of August, but was not ready for work until the last of November on account of the repairs necessary and the delays in making them.

About the middle of September, when it was thought the dredge would be ready for work in a few days at the very latest, the administrator began driving down the planking of the revetment into the ditch the water had dug under it, but after one day's work stopped. After that time he did nothing, and although every effort was made to have

Digitized by Google

him complete the work, he would not do so, and the contract was annulled January 3, 1888.

Authority was obtained from the Chief of Engineers to do the work by hired labor and open market purchase, using the Government dredge, which had shortly before finished the improvement of Bayou Terre Bonne. A careful examination developed the fact that the revetment was so badly wormed as to be worthless, and as this showed the life of timber to be short there, application was made to so far modify the project as to omit the revetment. The Chief of Engineers approved the modification January 12, 1888. The work of putting the dredge in condition was at once begun and completed in about 4 weeks. Bad weather in the Gulf caused a few days' delay, as it was necessary to pick weather for the long outside tow of 200 miles, but the dredge arrived and began work on the 19th of March.

In the mean time two deck barges had been hired and arranged for use as dump scows, but 2 days' work with them showed that the wooden shafts or Spanish windlasses used for closing the dumping doors were not strong enough. These were placed with 3-inch iron shafting and worked well.

The dredge took out in all 77,159 cubic yards, completing the work as projected August 31, 1888.

In 1888, $10,000 was appropriated for continuing this work, but as the former work had not proved permanent and the amount was too small to begin operations with it was held subject to future consideration.

As projected the work was not permanent, and at present the dredged channels have almost entirely disappeared. In order that the merchandise of the country bordering the Calcasieu River may find a safe water route to the Gulf, it is essential that the bars at the head and foot of Calcasieu Lake, or what is known as the passes of Calcasieu River, have channels through them of about 8 feet depth, and if it is proposed to continue this improvement the channel should be revetted to insure permanency.

This will cost $150,000.

In 1890, $75,000 was appropriated for "improving the mouth and passes of Calcasieu River" according to the plan reported by Major W. H. Heuer, Corps of Engineers, in 1886, and confirmed by Capt. W. L. Fisk, Corps of Engineers, in his report of November, 1888.

As this project was for the improvement of the mouth of the Calcasieu River by means of jetties, etc., which must be built in a very much exposed location in the Gulf, the amount available was considered to be entirely too small to commence operations with, economically, and is accordingly held for further increase. The sum of $200,000 can be judiciously expended upon this work the ensuing year.

The principal export is lumber, and if suitable water transportation existed the products of the mills on the Calcasieu River could be marketed for about $2 per thousand feet less than it is at present, an aggregate saving to the consumer of about $40,000 a year.

Money statement.

July 1, 1890, balance unexpended	$9,997.00
Amount appropriated by act approved September 19, 1890	75,000.00
	84,977.00
June 30, 1891, amount expended during fiscal year	41.60
July 1, 1891, balance unexpended	84,935.40

Digitized by Google

Amount (estimated) required for completion of existing project $525,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1893 350,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts 1866 and 1867.

COMMERCIAL STATISTICS.

Having been unable so far to obtain commercial statistics for the fiscal year just closed, those embraced in last annual report are appended:

Number of vessels, 1888-'89	34
Total registered tonnage of same	1,243.58
Aggregate number of trips out of river	
Aggregate tonnage of same	881

Articles.		June 1, 1888, to May 31, 1889.	
		Quantity.	Value.
OUTWARD FREIGHT.			
Cotton	bales	255	$12,750
Cotton seed	sacks	18,975	284,625
Hides		1,614	1,615
Alligator hides		2,562	3,202
Lumber	feet	25,140,000	377,100
Shingles		7,252,000	21,756
Miscellaneous freight	tons	187	3,740
Total			704,788
INWARD FREIGHT.			
Flour	barrels	5,537	22,148
Meal	do	5,983	11,966
Sugar	do	1,280	23,040
Molasses	do	1,000	8,000
Rice	do	232	754
Coal oil	cases	3,958	11,874
Oats	sacks	6,011	7,514
Corn	do	12,414	12,414
Bacon	cases	587	17,610
Whisky	barrels	87	4,350
Miscellaneous freight	tons	1,434	28,680
Total			148,350
Outward freight	tons	7,667	704,788
Inward freight	do	4,270	148,350
Total		11,937	953,138

S 10.

IMPROVEMENT OF HARBOR AT SABINE PASS, TEXAS.

The object of the improvement is to obtain a deep-water channel through the bar into the harbor. Originally the bar had but 6 feet of water upon it.

In 1878 and 1880 channels from 12 to 16 feet deep were dredged through the bar, but as no protection for the cuts thus made was provided they soon filled up. In 1882 a project was adopted for improving this harbor by means of two jetties of brush and stone, aided by dredging, if necessary, at a total estimated cost of $3,177,606.50.

Since the approval of this project appropriations amounting to $1,098,750 have been made, of which sum $300,000 became available by the river and harbor act of September 19, 1890, and is now under contract to be expended during the ensuing year. All the work done under these appropriations has been by contract.

Digitized by Google

It is proper to remark that the appropriations have come at intervals of 2 years and that in 8 years about one-third of the estimated cost of the improvement has been appropriated. Instead of the improvement being completed as it should have been to obtain the best results both commercially and in an engineering point of view, it is but about one-third completed and the situation would be disheartening were it not for the fact that the results have been more favorable than was to be expected.

CONDITION OF THE WORK.

The present total length of the east jetty built is 17,100 feet (3¼ miles) of which the outer 450 feet consists of foundation work only, to prevent scour around the end. The total length of the west jetty built is 9,500 feet, its outer extremity being abreast of 13,000 feet on the east jetty.

The 2,500 feet of the outer end of this jetty was only built to within 5 to 8 feet of the surface of the water, or, properly speaking, is foundation work only.

An experimental section 240 feet long was constructed at the outer end of the east jetty. The foundation of this section is 112 feet wide, and the riprapping consists of rubblestone faced with blocks of stone weighing from 1 to 3 tons. Its crest was, at the close of work, about 4½ feet above mean low water.

In December, 1889, a survey of the pass was made and the results are given in the Annual Report of 1890 of Captain Fisk, Corps of Engineers.

February 10, 1891, a Board of Engineer Officers was convened at Sabine Pass to consider the subject of further improvements, etc.

The Board made an inspection of the jetties, and in their report to the Chief of Engineers recommended that the jetties which had settled some since being built, and also suffered some loss in height from wave action and other causes, should, in order to concentrate the scouring effect of the ebb current upon the bar, be covered with large stone, the crest of this covering to be placed 2 feet above the level of high water; also that the west jetty be extended as far as the funds available would permit.

The recommendations of the Board having been approved, advertisements were issued inviting proposals for doing the work, and on the 11th of April the bids received were opened and Messrs. Charles Clark & Co., of Galveston, Tex., were found to be the lowest bidders. The contract was duly approved May 27, 1891.

A reëxamination of the pass has just been completed and a map of the survey is attached.

It will be observed that the 6-foot curve of depth has practically disappeared from between the jetties, the bar having but 6 feet depth upon it which stretched nearly across the channel at time of last survey, having been scoured out to a depth of about 9 feet.

The curves of 10 feet depth have joined and there is now a channel about 1,000 feet wide between the jetties having 10 feet or more depth. Near the outer end of the east jetty this channel stretches from the east jetty to nearly the full width of the span between the jetties.

The 12-foot curve of depth has advanced slightly on the inside and the channel is wider. Outside this curve has not changed its position materially, a favorable circumstance.

Behind the west jetty there has been a considerable shoaling, the 6-foot curve of depth has advanced materially, and the shore has also built out some.

The outer end of the east jetty shows some reduction in height since

Digitized by Google

Digitized by Google

Digitized by Google

last survey and the crest of the rock section has flattened out a little, otherwise the changes are not of material consequence.

Until a more substantial capping is applied to the outer ends of the jetties it is impossible to tell whether the loss of height is due to subsidence or to displacement of the small rock by the action of the waves.

Considering the unfinished condition of the works the results are encouraging.

Money statement.

July 1, 1890, balance unexpended		$3,814.03
Amount appropriated by act approved September 19, 1890		300,000.00
		303,814.03
June 30, 1891, amount expended during fiscal year		5,486.47
July 1, 1891, balance unexpended		298,327.56
July 1, 1891, outstanding liabilities	$1,268.94	
July 1, 1891, amount covered by uncompleted contracts	270,000.00	
		271,268.94
July 1, 1891, balance available		27,058.62
Amount (estimated) required for completion of existing project		2,078,856.50
Amount that can be profitably expended in fiscal year ending June 30, 1893		1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received for improving harbor at Sabine Pass, Texas, opened at New Orleans, La., April 11, 1891, by Major James B. Quinn, Corps of Engineers.

No.	Name and residence of bidder.	Brush mattresses in place per square yard (25,000 square yards).	Riprap stone in place per ton of 2,240 pounds (35,000 tons)	Capping blocks in place weighing from 1 to 4 tons (2,240 pounds to the ton, 32,500 tons).	Total amount of proposal.
1	Wm. Z. Partello, 913 Seventh street, N. W., Washington, D. C.	$2.10	$4.50	$6.50	$421,250
2	Woodward, Wight & Co., Limited, New Orleans, La.	2.50	4.00	6.00	397,500
3	Charles Clarke & Co., Galveston, Tex.	1.70	3.29	4.80	313,650
4	John F. Gayner, Fayetteville, Ky.	1.75	3.45	4.91	324,075
5	Alabama Dredging and Jetty Company, Mobile, Ala.	2.05	3.80	4.90	343,500

Contract awarded to Charles Clarke & Co., of Galveston, Tex., with the approval of the Chief of Engineers, for so much of the work as it may be possible to do for the sum of $270,000. Contract dated May 1, 1891, and approved May 27, 1891. Work to be commenced within 90 days after the approval of contract and completed on or before July 15, 1892.

Digitized by Google

COMMERCIAL STATISTICS.

During the present fiscal year custom-house records show clearances of vessels aggregating 1,494 registered tons with cargoes aggregating 1,616,000 feet of lumber.

	June 1, 1890, to May 31, 1891.	
	Quantity.	Value.
OUTWARD FREIGHT.		
	Tons.	
Cotton	50	$10,800
Cotton seed	130	2,600
Hides	12	1,200
Alligator skins	80	6,000
Shingles	480	3,600
Lumber	3,332	19,992
Total	4,084	42,792

Inward freight: General merchandise, flour, meal, sugar, whisky, etc., which it is impossible to classify separately, based on annual sales, $125,000.

REPORT OF BOARD OF ENGINEERS ON IMPROVEMENT OF SABINE PASS, TEXAS.

NEW ORLEANS, LA., *February 11, 1891.*

GENERAL: The Board constituted by Special Orders 89, paragraph 1, Headquarters, Corps of Engineers, December 27, 1890, on the improvement of Sabine Pass, Texas, having duly considered the project of Capt. W. L. Fisk, Corps of Engineers, for the expenditure of $300,000 now available for the work, contained in his letter dated December 18, 1890, with its indorsements, and referred to it, has the honor to submit the following report:

The Board is of the opinion that the settlement of the crest of the jetties reported from time to time is due to the descent of the entire structure into the mud; to the compression of the brush mattresses; to the loss of brush by the action of the teredo, and to the loss of brush and stone by wave action. It is unable to state definitely what proportion of loss is due to each cause. It is of the opinion, however, that the use of brush above the jetty foundation is unavoidably attended by compression and loss of height and should be discontinued as far as possible.

The Board found that the foundation of the experimental stone section has settled in all about 3 feet into the mud, and that this settlement has been practically nothing in the past 14 months. The state of this section also seems to indicate that a jetty constructed of stone, on a brush foundation of proper width and covered with stone of a suitable weight, can be built in the mud bottom found at Sabine Pass without serious settlement, and that such a jetty will be more permanent than one constructed of alternate layers of brush and small stone.

As a portion of the loss of height of the jetty may be attributed to wave action, the Board is of the opinion that the old portions of the work should be covered with heavy blocks of stone.

To allow for future subsidence and to control the ebb currents the Board would recommend that the crest of this covering be placed 2 feet above the level of mean high water.

Digitized by Google

It is further the opinion of the Board that the most immediate scouring effect on the bar can be obtained by an extension of the west jetty.

For all of these reasons the Board would recommend that the work be done in the following order, and that a project and estimate be prepared in accordance therewith:

1. *East jetty.*—Raise jetty to 2 feet above mean high water for the first 16,600 feet, using blocks weighing up to 2,000 pounds for the first 3,000 feet, thence to the 6-foot curve blocks weighing up to 2 tons, and blocks up to 4 tons for the remaining distance.

2. *West jetty.*—Raise jetty to mean high-water level for the first 4,000 feet, using blocks up to 2,000 pounds; thence to the end of the jetty 2 feet above mean high water, using blocks weighing up to 2 tons as far as the 6-foot contour and up to 4 tons beyond. Extend jetty with stone on a mattress foundation, with the crest 2 feet above mean high water and a covering of stone up to 4 tons in weight, as far as funds will permit, keeping the ballasted mattress foundation at least 300 feet in advance of the finished work.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
JAMES B. QUINN,
Major of Engineers.
W. M. BLACK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 16, 1891.

Approved.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

S 11.

IMPROVEMENT OF SABINE RIVER, TEXAS.

A survey of the mouth of this river was made in 1871. It had a channel over the bar 3½ feet deep. In 1872–'73 the survey was extended from the mouth to Belgora, Tex. The information obtained did not warrant the expenditure of any money of improvement above Hamilton, Tex., about 247 miles above the mouth, to which point there is 3 feet depth for about 3 months in each year.

The estimated cost of improvement over this stretch of river by removal of obstructions such as logs, snags, fallen trees, etc., was $18,000.

In June, 1878, Congress appropriated $10,000 for the improvement with which a channel 6 feet deep, 70 to 100 feet wide, was dredged over the bar at the mouth.

March 3, 1879, Congress appropriated $6,000 more, and provided for a resurvey of the river from its mouth to East Hamilton.

After the survey was completed it was deemed advisable to spend

Digitized by Google

this money in improving the river above Orange, and cuts were made from the main river into the narrows and at Dead Bend.

Large numbers of sunken logs and snags were removed from the upper part of the narrows, enabling vessels of 5 feet draft to get [illegible] miles above Orange.

In 1880 Congress appropriated $5,000 and in 1881 $7,000 more for this river. The bar at the mouth had again shoaled. This was redredged in 1881–'82 to a depth of 6 feet, and a channel 100 feet wide was made a little over 1 mile in length, which still remains in fair condition.

In 1882 Congress appropriated $4,000 more for this improvement.

As the river was in a sufficiently good condition for the limited commerce which it carried this money was held for further use.

An examination in May, 1889, showed many snags and some shoal places in the part of the channel known as The Narrows, and as soon $4,000 was available for work, a project was submitted for removing the snags and closing the two "Old River" branches with dams of piles, brush, and earth, to throw all the water into The Narrows.

This project was approved, the work advertised, and contract was entered into September 20, 1889, with the Sabine Tram Company to complete the work by December 1, 1889, for $3,647.

The smaller dam was successfully built, and most of the piles driven for the larger one, when a sudden rise in the river washed out many of them. The water continued rising, and remained so high that satisfactory work could not be done, so the contract was extended to October 30, 1890, by the Chief of Engineers. Work was resumed in September, 1890, and finished in December of that year, finishing the project.

There has been expended $34,614.12 to June 30, 1891.

Money statement.

July 1, 1890, balance unexpended	$3,938.61
June 30, 1891, amount expended during fiscal year	3,852.73
July 1, 1891, balance unexpended	85.88

S 12.

IMPROVEMENT OF NECHES RIVER, TEXAS.

The river was surveyed in 1872 and 1873, and resurveyed from Bevilport to its mouth. The following are the appropriations made for the river:

June 18, 1878	$8,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	3,000
August 2, 1882	5,000
July 5, 1884	7,000
Total	33,000

The project contemplated dredging a channel over the bar at the mouth of the river and the removal of obstructions from the river between Bevilport and Yellow Bluff.

The bar at the mouth was dredged in 1880, and a channel 5 feet deep and 30 to 60 feet wide was obtained.

Digitized by Google

In 1882 the obstructions between Yellow Bluff and Bevilport were removed. The original estimated cost for making these improvements was, for work at the mouth of the river $26,318.05, and for up river $15,000; a total of $41,318.05.

The bar at the mouth of the river again shoaled, until at extreme low water there was a depth of about 3 feet over it.

There is very little commerce passing in and out of the river, but as the bar at this place was the shoalest obstruction between the Gulf and Beaumont, Texas, and the money was available for dredging the bar, it was thought advisable to reopen this channel.

For this purpose the Government dredge, which had completed work at the head of the Calcasieu Pass, was placed in good repair and sent over to the mouth of the river in December, 1888. By the 1st of May the dredge had removed 55,482 cubic yards and completed a 5-foot channel across the bar, following the old one, of which traces still remained.

The total amount thus far spent upon the river is $28,842.16, leaving still unexpended $4,157.84.

The dredged channel can not be expected to be permanent in such a broad and shallow body of water as Sabine Pass, but will probably serve all the necessities of the commerce using it for several years.

Money statement.

July 1, 1890, balance unexpended	$4,157.84
July 1, 1891, balance unexpended	4,157.84

S 13.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

In December, 1890, the British bark *Bruce* sunk in Ship Island Harbor, Mississippi. It was reported an obstruction to navigation, and authority having been obtained to remove it by contract, advertisements were issued inviting proposals, and the bids received in response were opened April 27, 1891, and the contract awarded to the Alabama Dredging and Jetty Company, of Mobile, Ala., the lowest bidders, for the sum of $1,490.

The work of removal by the contractors was commenced on June 19, 1891, and is not yet finished.

Abstract of proposals for removal of wreck of bark Bruce from Ship Island Harbor, Mississippi, opened at New Orleans, La., April 27, 1891, by Major James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Total price bid.
1	William H. Keates, Somers Point, N. J.	$5,581
2	Ethen A. Burriss, New Orleans, La	4,500
3	Peter Keveney and James Moore, New Orleans, La	3,250
4	John W. Glenn, New Orleans, La	2,489
5	James Henry Lynch, New Orleans, La	3,700
6	Alabama Dredging and Jetty Co., Mobile, Ala.	1,490

Digitized by Google

S 14.

PRELIMINARY EXAMINATION OF BAYOU CARLIN, LOUISIANA.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 14, 1891.

GENERAL: As directed by letter from your office of June 29, 1891, I have the honor to submit the following report upon my preliminary examination of Bayou Carlin, Louisiana, which was made on the 12th instant:

This Bayou lies partly in Iberia and partly in Vermillion Parishes, La. It is very crooked and but 6 miles long. It rises in Peigneur Lake and flows in a southerly direction to its junction with Petit Anse Bayou. This latter bayou flows into Vermillion Bay and is navigable for small steamboats and schooners to a point above the mouth of Bayou Carlin, and Bayou Carlin was navigable for about 3 miles of its length until a short time back.

Bayou Carlin is only 14 or 15 feet wide and from 3 to 5 feet deep. Its current is about 2 miles an hour, and it receives the drainage of about 200 square miles of country. It always has a good volume of water in the dryest seasons, and during the wet seasons it is out of its banks.

The lands along the bayou are very fertile, but can not be profitably farmed for want of suitable transportation.

The land about Lake Peigneur is high and rolling. Below this the land is flat. The nearest market is New Iberia, and during the winter, when the crops are ready for transportation, the roads are well nigh impassable. If Bayou Carlin was opened up and made navigable it would give a much-desired outlet to this fertile country.

It is estimated that there would be shipped by water the first year at least 2,000 barrels of rice, 1,000 bales of cotton, 500 hogsheads of sugar, 6,000 barrels of corn, and many head of live stock. Large quantities of lumber and coal would also be received this way. As the country would settle up in consequence of the improved facilities for getting the crops to market the shipments would naturally increase with time.

The bayou would need to be dredged to a depth of 7 feet and a width of 30 feet, and be straightened considerably. This would cost about $40,000. Once completed the channel would require but little attention.

For the foregoing reasons I consider the bayou worthy of improvement.

A detailed survey is estimated to cost $200 in addition to the balance of $28.08 on hand from the allotment for the preliminary examination.

The letters from Capt. Eric Bergland, Corps of Engineers, of October 15, 1884, and January 16, 1885, and letters from Mr. Clermont Young, of April 7, May 25, and June 25, 1891, which were sent me with your communication, are herewith returned as directed.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

Digitized by Google

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, August 17, 1891.

Respectfully forwarded to the Chief of Engineers.

According to the maps Lake Peigneur is about 10 miles from the railroad at New Iberia, and the within paper shows that in the winter the roads are very bad.

Accordingly it is desired that Bayou Carlin, 6 miles long, 15 feet wide, and very crooked, be dredged out and straightened, so as to give a water outlet to the lands about Lake Peigneur and Bayou Carlin.

The estimated cost is $40,000.

As a good road to New Iberia seems to be what is needed, and as its cost would probably be less than $40,000, this improvement does not seem to me worthy of being made by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 15.

PRELIMINARY EXAMINATION OF SHOALS ON LAKE PONTCHARTRAIN, LOUISIANA, NEAR THE RIGOLETS, KNOWN AS THE "MIDDLE GROUND," WITH A VIEW OF DREDGING A CHANNEL 10 FEET DEEP AND REVETTING SIDES OF THE SAME.

[Printed in House Ex. Doc. No. 111, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1890.

SIR: I have the honor to submit herewith a copy of report, dated November 25, 1890, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of "shoals on Lake Pontchartrain, Louisiana, near the Rigolets, known as the 'Middle Ground,' with a view of dredging a channel 10 feet deep and revetting sides of the same," made to comply with the provisions of the river and harbor act of September 19, 1890.

It is the opinion of Captain Fisk that, on account of the cost and the fact that only 8 feet of water can be carried through the western end of Mississippi Sound after leaving the Rigolets, these shoals are not worthy of improvement as proposed in the act; and Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, agrees with this opinion. I concur in these views.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 25, 1890.

GENERAL: From Coast Survey charts and other available data I am able to submit the following report on preliminary examination of "shoals on Lake Pontchartrain, near the Rigolets, known as the 'Middle

Digitized by Google

Ground,' with a view of dredging a channel 10 feet deep and revetting sides of the same."

The traffic crossing these shoals is considerable and consists mostly of lumber, wood, sand, shells, and charcoal, which are brought to New Orleans through the two canals leading from Lake Pontchartrain to the city in small schooners drawing not more than about 6 feet.

The depth of water that can be carried over the shoals at mean low tide must be at least 6 feet, as the light-house tender *Pansy*, drawing full 7 feet, frequently comes into the lake without trouble, and the tide at the outer (eastern) end of the Rigolets, which is given by the Coast Survey as only 10 inches, must be still less at the shoals.

An examination of the chart shows the distance from 10 feet depth in the Rigolets to the same depth in the lake, on the shortest possible line, to be 4 statute miles, requiring dredging roughly estimated at 475,000 cubic yards to obtain a channel of only 100 feet bottom width.

The cheapest form of revetment would probably be one of piles and sheet piles, and to be of any permanence all the timber should be creosoted. A revetment of this kind on the two sides of the cut would cost about $180,000; the dredging would probably cost 20 cents per cubic yard, or $95,000 more; a total cost of $275,000.

If this were all done it would not be of much value, for at the mouth of the Rigolets there is very little more water than on the "Middle Ground," and as a matter of fact not more than about 8 feet at low water can be carried in the western end of Mississippi Sound after leaving the Rigolets.

I am of the opinion that the improvement as specified is not worthy of being made on account of its great cost and the fact that only 8 feet of water can be carried through the western end of Mississippi Sound.

A channel 8 feet in depth at low water would answer every purpose; it would require the dredging of about 230,000 cubic yards on the "Middle Ground" and about 50,000 cubic yards at the eastern end of the Rigolets, or about 280,000 cubic yards in all, at a cost of about $56,000. To revet both these cuts would require so large a sum of money that it is probable the annual interest upon it would suffice to keep the channel open by dredging only, thus avoiding the expense of maintaining and renewing the revetment.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Repectfully forwarded to the Chief of Engineers.

I do not think these shoals worthy of improvement in the way proposed in the river and harbor act of 1890.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Digitized by Google

S 16.

PRELIMINARY EXAMINATION OF BAYOU CHEVREUIL AND BAYOU TIGRE, LOUISIANA, FROM LAKE DES ALLEMANDS TO POINTS NEAR VACHERIE, CHIGBY AND MALAGAY SETTLEMENTS IN ST. JAMES PARISH FOR REMOVAL OF BARS AND OTHER OBSTRUCTIONS TO NAVIGATION.

[Printed in House Ex. Doc. No. 182, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 15, 1891.

SIR: I have the honor to submit the accompanying copy of report dated January 9, 1891, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Chevreuil and Bayou Tigre, Louisiana, "from Lake Des Allemands to points near Vacherie, Chigby and Malagay settlements in St. James Parish for removal of bars and other obstructions to navigation," made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk reports that Bayou Tigre is not worthy of improvement, and, in his judgment, the circumstances are not such as to require the improvement of Bayou Chevreuil by the United States. The Division Engineer, Col. C. B. Comstock, Corps of Engineers, concurs in this opinion, and the views of these officers meet with my approval.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., January 9, 1891.

GENERAL: I have the honor to submit the following report of preliminary examination of "Bayou Chevreuil and Bayou Tigre from Lake Des Allemands to points near Vacherie, Chigby, and Malagay settlements in St. James Parish, La., for removal of bars and other obstructions to navigation."

Bayou Chevreuil extends from near Donaldsonville to Lake Des Allemands, although in places called by other names, and flows along the lowest levels between the Mississippi and the La Fourche. It is the principal drainage outlet of that part of the State, or would be if opened.

Previous to the Davis Crevasse it was free from obstructions to a point several miles above the limits of this examination, and was used by several sugar-planters in the Chigby settlement to send their crops to New Orleans. This was mainly done in barges, but a small steamer made occasional trips for that purpose.

From Lake Des Allemands to the upper landing of Chigby is about 10 miles, 3 of which is through open marsh. The bayou in the timber has an average width of 100 feet and a depth of not less than 10 feet.

Digitized by Google

It is badly obstructed with logs and overhanging timber and in parts is completely closed by grass.

To remove these obstructions and cut the overhanging timber would cost about $7,500.

Bayou Tigre is not a bayou, but simply a passage which has been opened through the swamp to permit the passage of pirogues between the Vacherie and Chigby, as the inhabitants of the latter are mainly laborers who work on the plantations in the former.

Bayou Tigre has no defined channel and at the time of the examination had scarcely enough water to float an empty canoe. Save for the blazes on the trees, it differs in no wise from the surrounding swamp and at many points it is difficult to pass between the trees.

The Vacherie settlement extends from near Lake Des Allemands in a northwest direction for about 5 miles. The ridge is parallel to Bayou Chevreuil and distant from it 2 to 3 miles. There are about 4,000 acres of arable land open and cultivated, nine sugar houses, and numerous small farms. The population is about 1,500, and the annual exports are 1,800 hogsheads of sugar and 3,500 barrels of molasses.

The Malagay and Chigby settlements, practically the same, are located on a ridge commencing about 1 mile above the mouth of Bayou Bœuf and extending thence in a northwest direction parallel with Bayou Chevreuil and generally about 1 mile from it. Their population is about 2,000 and they produce about 4,000 barrels of sweet potatoes for the market.

It is evident from the description that Bayou Tigre is not worthy of improvement, as it could only be accomplished by digging a canal 3 miles in length through a heavily timbered swamp, and in my judgment the circumstances are not such as to require the improvement of Bayou Chevreuil by the United States.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 12, 1891.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated, I concur in the opinion of the district officer, that bayous Chevreuil and Tigre are not worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen. U. S. A.,
Division Engineer.

Digitized by Google

S 17.

PRELIMINARY EXAMINATION OF BAYOU TERRE BONNE, LOUISIANA, FROM HOUMA TO THIBODEAUX.

[Printed in House Ex. Doc. No. 110, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 20, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report, dated November 5, 1890, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Terre Bonne from Houma to Thibodeaux, La., made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk states this subject was fully investigated in 1886 by Lieut. O. T. Crosby, Corps of Engineers, whose adverse report thereon is printed in the Annual Report of the Chief of Engineers for 1887, pages 1396–98. He reports the circumstances the same now as at that time, and that he, too, is of opinion that the locality is not worthy of being improved.

Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, also reports that Bayou Terre Bonne, from Houma to Thibodeaux, is not worthy of improvement, and I concur in the views of these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 5, 1890.

GENERAL: Regarding the preliminary examination of Bayou Terre Bonne from Houma to Thibodeaux, La., assigned to me by letter of September 20, 1890, from your office, I beg to say that this identical subject was fully investigated in 1886 by Lieut. O. T. Crosby, Corps of Engineers, who reported it as not worthy of improvement, and his opinion was fully concurred in by my predecessor, Maj. W. H. Heuer, Corps of Engineers (Annual Report Chief of Engineers for 1887, pages 1396–1398).*

The circumstances now are the same as at that time, and I also am of the opinion that Bayou Terre Bonne from Houma to Thibodeaux, La., is not worthy of being improved.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

*Appended hereto.

Digitized by Google

[Third indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Respectfully returned to the Chief of Engineers.

I am of opinion that Bayou Terre Bonne from Houma to Thibodeaux is not worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
Division Engineer.

LETTER OF MAJOR W. H. HEUER, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 9, 1886.

GENERAL: I forward herewith a report of First Lieut. Oscar T. Crosby, Corps of Engineers, being a result of an examination of the Bayou Terre Bonne between Houma and Thibodeaux, La., as called for by the river and harbor act of August 5, 1886.

Lieutenant Crosby's report shows that the greater portion of the bayou above Houma is a bayou only in name, parts of it being dry and other parts being only a drainage ditch. Under these circumstances the part examined is certainly not a navigable stream. It can only be made navigable by making a canal in what was once the bed of the bayou, now practically dry.

I concur fully with Lieutenant Crosby, for reasons which he gives, that the bayou between Houma and Thibodeaux is not worthy of public improvement.

Very respectfully,

W. H. HEUER,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT O. T. CROSBY, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 8, 1886.

SIR: I have the honor to report as follows upon a preliminary examination of Bayou Terre Bonne from Houma to Thibodeaux, La., recently made by me under your orders:

The distance from Houma to Thibodeaux is about 16 miles. Thibodeaux is the point at which Bayou Terre Bonne, in years past, drew its water supply from Bayou La Fourche, and thus indirectly from the Mississippi. This connection has long since ceased to exist.

Houma is situated at the head of navigation on Bayou Terre Bonne, which continues its course to the Gulf, connecting laterally with other streams and lakes by partly artificial, partly natural, water ways until the Mississippi is reached opposite New Orleans. The boats running on this lower part of Bayou Terre Bonne are small, and are at times, at this season, prevented from running during several weeks by lack of water. These difficulties of navigation are being overcome by dredging, the work under the last Congressional appropriation having reached a point about 10 miles below Houma, with money enough still available to continue dredging a channel 35 feet wide by 5 feet deep (below Gulf level) to within 3 or 4 miles of Houma—perhaps closer. It is hoped that completion of the improvement to Houma, by affording uninterrupted navigation, may result in a reduction of rates through competition between water and rail.

At Houma the stream is now about 2.5 feet deep and perhaps 40 feet wide, though, the cross section being very flat, much the greater part of this width is covered by water only a few inches deep. The fact that a towboat of about 14 feet beam and 18 inches draft can not run sufficiently shows the condition of the stream. The bed of the stream is overgrown with marsh and water grasses.

For a distance of 3 miles above Houma there is practically no change; the width

Digitized by Google

varies somewhat, the depth correspondingly, the cross section remaining about the same. At this point, 3 miles above Houma, the Terre Bonne is fed by Bayou Cane, a short stream about 15 feet wide and 500 or 600 yards long, leading out from a great swamp reservoir. It is called sometimes a lake, sometimes a prairie or floating prairie. It is a basin, receiving the drainage from the country between bayous Black and Terre Bonne. It is at times covered by a heavy growth of water grass; hence the name of floating prairie. There is at all seasons, even now after a long drought, some outflow; it is this outflow that supplies the small volume now flowing through Bayou Terre Bonne.

Beyond Bayou Cane the Terre Bonne is practically dry. Since its bottom lies several feet below the roads along its bank there is, of course, a little seepage water here and there, sometimes in holes 2 or 3 feet deep. A few miles above the Cane the course of the bayou is traced by the shallow depression of its former bed and the line of rushes, which conceals whatever water may lie under them. In many places the bed is perfectly dry. As Thibodeaux is approached the bed is found to be continually dry, so that even the rushes can not grow. Here ditches have been dug in the former bed to assist in draining the road, and finally the "bayou" becomes simply a part of the system of drainage ditches of the town of Thibodeaux. It will be seen from this description, which is that of its ordinary state, that the term *Bayou* Terre Bonne is traditional rather than veritable. During seasons of heavy rain there is, of course, some water in the old bed, but no boat can go farther up than Bayou Cane. The owner of the *Harry*, one of the two towboats now tied up at Houma, informed me that he sometimes ascended to the Cane in order to open the water grass, thus permitting a freer flow of the prairie water into the Terre Bonne. He said that to go beyond that point would require not the improvement of an existing water way, but the construction of a canal. Such, indeed, is the fact. That such a work would be of some benefit can not be doubted, as water routes throughout an agricultural country are always desirable; that its construction, considered from the engineer's point of view, is feasible, even easy, can not be doubted; but it is equally evident that the work can not be recommended as the improvement of a water way. To create one, taking advantage of the depression in the general surface caused by previous flow of a considerable body of water through what was an outlet of the Mississippi, would involve the cutting of a channel to be filled by tide water, aided somewhat by drainage from a small area. Such a cut would involve the removal of about 850,000 cubic yards of earth, the depth being 5 feet, the width 30 feet. The dredge below Houma is removing earth at a cost of about 4 cents per cubic yard, counting running expenses alone. It would probably be safer to estimate 10 cents as the cost, including plant, superstructure, etc., or about $85,000 for a tidal canal to Thibodeaux.

As the road which follows the bayou bed is at many points quite near the line that would mark one side of the cut, there might arise embarrassing, perhaps costly, considerations as to the injury done this road. Of this, however, nothing certain can be said. At Terre Bonne, or as it is now called Schriever Station, it would be necessary to have a drawbridge constructed in the line of the Southern Pacific Railroad. As the stream was not navigable when this road was constructed, it is probable that the owners could demand compensation. On account of these and other contingencies, impossible to foresee, it would be prudent to place the final cost at not less than $100,000.

The strip of cultivable land between the bayou and the swamp lying on either side will average not more than half a mile in width, or a total of 16 square miles. About half of this is now under cultivation, while the other half has been abandoned. Some small corn and rice farms are beginning to appear on the abandoned sugar plantations. A branch road leaves the main line of the Southern Pacific at Schriever Station for Houma to the south, and another for Thibodeaux to the north, both branches lying not far from the proposed cut. Supposing the work completed to Thibodeaux, together with the work now progressing toward Houma on the lower bayou, the resulting benefits would be better drainage for the lands lying along the new water way; navigation for small boats from Thibodeaux to the Gulf. This route could scarcely be followed outside, as the small boats fitted for the canal would not be fitted for the Gulf voyage to the mouth of the Mississippi. They would go either to Thibodeaux, delivering there across the Bayou La Fourche Levee to boats running to New Orleans or to the railroad; or they would go south, then east by the small canals, bayous, and lakes constituting the present Lugger Route. In either case active competition with the railroad would be difficult, perhaps impossible. The canal would probably serve as an excellent local highway, and would be much appreciated for its aid as a drainage stream. Perhaps it was necessary that this report should go no further than to show that the proposed work could not properly be recommended as the improvement of an existing water way, but knowing as I well do the great importance of improved transportation routes to the rich agricultural country through which the examination took me, I have gone further to show what would result from constructing a water way along the line considered. View-

Digitized by Google

ing it in this light, I can not refrain from drawing attention to the fact that in this case, as in others in the same section, recommendations would almost entirely be reversed could the works be considered not separately and as unconnected, but as parts of a system of short-line water communication through southern Louisiana to New Orleans. Considered separately, improvements such as that under discussion appear as local highways, lessening the use of wagon transportation to railroad stations; considered as parts of a whole they appear as water routes permitting actual competition for products of great value with the railroad, which now practically controls the business of this rich section. Thus the value of any improvements in the Terre Bonne section is immensely increased; its character becomes much more national if it be connected with Bayou La Fourche and at the same time it be known that that important stream is to receive some definite treatment.

In conclusion, the work is not, in my opinion, a public necessity, its local character appearing plainly from what precedes; and "Bayou Terre Bonne from Houma to Thibodeaux" is not worthy of improvement, in the sense in which those words have been used in river and harbor acts.

Very respectfully, your obedient servant,

O. T. CROSBY,
First Lieutenant of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S 18.

PRELIMINARY EXAMINATION OF BAYOU BLACK TO CONNECT WITH TERRE BONNE, LOUISIANA.

[Printed in House Ex. Doc. No. 113, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 5, 1890, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Black to connect with Terre Bonne, Louisiana, made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk calls attention to former adverse report of December 12, 1888, printed in Annual Report of the Chief of Engineers for 1889, pages 1508, 1509, and states that the reasons then given are equally strong now, and he is still of the opinion that this is an improvement not worthy of being made. Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, also reports that Bayou Black to connect with Terre Bonne is not worthy of improvement, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 5, 1890.

GENERAL: Regarding the preliminary examination of "Bayou Black to connect with Terre Bonne, Louisana," assigned to me by letter of September 20, 1890, from your office, I beg to say that on December 12,

Digitized by Google

1888, I reported this improvement as not worthy of being made. (See Annual Report Chief of Engineers, 1889, pages 1508, 1509).

The reasons then given are equally strong now and I am still of the opinion that "Bayou Black to connect with Terre Bonne, Louisiana," is an improvement not worthy of being made.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[Third indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Respectfully returned to the Chief of Engineers.

I do not think the route "Bayou Black to connect with Terre Bonne" worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 19.

PRELIMINARY EXAMINATION OF BERWICK BAY, LOUISIANA, TO THE GULF, WITH A VIEW OF OBTAINING A DEEPER CHANNEL.

[Printed in House Ex. Doc. No. 198, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 20, 1891.

SIR: I have the honor to submit the accompanying copy of report, dated January 16, 1891, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Berwick Bay, Louisiana, to the Gulf, "with a view of obtaining a deeper channel," made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk does not consider that the present circumstances are such as to warrant the expenditure of the large sum which would be necessary for the increased depth, and the Division Engineer, Col. C. B. Comstock, Corps of Engineers, reports that the cost would be so great that he does not think the route worthy of improvement. I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

Digitized by Google

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans La., January 16, 1891.

GENERAL: From available data I am able to submit the following report upon preliminary examination of "Berwick Bay, Louisiana, to the Gulf, with a view of obtaining a deeper channel."

From Berwick Bay to the mouth of the Atchafalaya Bay the river is deep and requires no improvement.

From the river there is now 8 or 9 feet to sea, and as no depth is specified I assume that 12 feet is the least which can be considered as complying with the requirements of this examination. The estimate I have made is only a rough approximation, the data being taken from existing Coast Survey charts, which are not on a large enough scale to admit of more.

Two lines are considered, one the shortest air-line distance between the inner and outer 12-foot curves, the other following the existing Morgan's Cut (assumed to be 9 feet deep) through the bay and thence on the shortest line to the outer 12-foot curve. The width of the channel is assumed at 120 feet, the same as of Morgan's Cut.

The distance between the inner and outer 12-foot curves is 11⅓ miles, of which about 6⅓ miles is inside work and the remaining 5 miles in the open Gulf.

The inside dredging amounts to about 1,000,000 and that outside to about 500,000 cubic yards; estimating the former at 10 cents and the latter at 33⅓ cents per yard (both low prices, I think), the dredging alone would amount to $266,667.

Assuming that the cut through the bay would need no protecting revetment, it would certainly require considerable annual dredging to maintain it, while for the outside cut protection on both sides would be necessary, of strength at least equal to the jetties at Sabine Pass.

The cost of work of this character would be such that the dredging would appear as a comparatively insignificant item in the total.

Second line.—The distances to be dredged would be 8 miles inside the bay and 4 miles in the open Gulf, requiring the removal, respectively, of 600,000 and 200,000 cubic yards of material, which, at 10 cents and 33⅓ cents per yard, would amount to $126,667; to this it would be necessary to add the cost of 8 miles of outside protection work, thus again making the dredging a small item of the total estimate.

The foregoing are, as before stated, only rough approximations, but they give a fair idea of the magnitude and cost of the work if any material increase is to be made in the navigable depth through Atchafalaya Bay to the Gulf.

The vessels at present using the Atchafalaya River are two Morgan Line steamships, one running to Texas ports at intervals of 10 days or more and the other to Vera Cruz, Mexico, once in 2 weeks, about 25 schooners and 30 luggers and sloops passing in and out an unknown number of times.

The Texas steamer draws about 8 feet, and an increase of water at the mouth of the Atchafalaya River would do them no good, as more could not be carried into the Texas ports visited; probably none of the sailing vessels draw as much as the steamers.

In my opinion it is plainly evident from the foregoing that the present circumstances are not such as to warrant the expenditure of the

Digitized by Google

large sum which would be necessary for even the small increase of 3 feet in available depth.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 19, 1891.

Respectfully forwarded to the Chief of Engineers.

The cost of a satisfactory improvement would be so great that I do not think the route worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 20.

PRELIMINARY EXAMINATION OF BAYOU COCODRIE, IN SAINT LANDRY PARISH, LOUISIANA.

[Printed in House Ex. Doc. No. 114, Fifty-first Congress, second [session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 26, 1890, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Cocodrie, in St. Landry Parish, La., made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk reports that this stream is not in any sense navigable, nor can it be made so at reasonable expense; and Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, states that he does not think Bayou Cocodrie worthy of improvement. I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 26, 1890.

GENERAL: I have the honor to submit the following report upon the preliminary examination of "Bayou Cocodrie, in St. Landry Parish, La."

Digitized by Google

This stream is not in any sense navigable, nor can it be made so at reasonable expense.

There are in its course of 30 miles through the parish only a few persons living on or near it, and there is not now, nor has there ever been, any communication along it. At long intervals, during floods, a barge has been sent up some 6 miles for cotton, but this has not occurred for years.

At present it can not be navigated by a skiff and can only be approached at long intervals, where the roads cross it. There is a large country on the west which at some time in the future might be benefited by its improvement, but in my opinion existing circumstances are not such as to warrant any present expenditure.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Respectfully forwarded to the Chief of Engineers.

I do not think "Bayou Cocodrie, in St. Landry Parish," worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 21.

PRELIMINARY EXAMINATION OF BAYOU BLACK, LOUISIANA, FOR CONNECTION BETWEEN CALCASIEU LAKE AND SABINE LAKE.

[Printed in House Ex. Doc. No. 125, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 22, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report dated November 13, 1890, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Black, Louisiana, "for connection between Calcasieu Lake and Sabine Lake," made to comply with provisions of the river and harbor act approved September 19, 1890.

On account of the small interests to be subserved and the probable cost of the necessary work, Captain Fisk is of the opinion that the improvement of Bayou Black, as indicated by the act of September 19, 1890, is not worthy of being made by the General Government. Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Divi-

Digitized by Google

sion, states that he does not think Bayou Black worthy of improvement for the reasons given in this report, and I concur in this opinion.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 13, 1890.

GENERAL: I have the honor to submit the following report upon preliminary examination of "Bayou Black for connection between Calcasieu Lake and Sabine Lake, Louisiana," required by the river and harbor act of September 19, 1890.

The identical route was surveyed in considerable detail in 1874 as part of an examination for an inland water way from the Mississippi River to the Rio Grande River, Texas (see Annual Report Chief of Engineers, pp. 889–893), and from the data then gathered it was found that to obtain a channel only 60 feet wide at bottom and 6 feet in depth it would be necessary to excavate 1,061,359 cubic yards of material at an estimated cost of $426,534.20, and that additional work at the mouth of Sabine River would cost $100,904.76 more, or a total of $527,438.96.

At the present time dredging can be done at considerably less cost than estimated then, say 20 cents per cubic yard, or $212,272 for dredging only, to say nothing of the cost of maintaining the channel after obtaining it, which would hardly average less than $5,000 per annum.

The principal advantage to be gained by making this channel would be the possibility of sending barges of lumber in tows from the mills on Calcasieu River to be loaded for export on vessels at the harbor of Sabine Pass.

It is desired, I am informed, by only a small minority of the Calcasieu mill-owners, the majority of whom prefer the direct shipment of their lumber through Calcasieu Lake and Pass to Gulf ports in schooners loading at their mills or in the deep water of Calcasieu Pass.

On account of the comparatively small interests to be subserved and the large probable cost of the necessary work, I am of the opinion that the improvement of "Bayou Black, for connection between Calcasieu Lake and Sabine Lake, Louisiana," is not one worthy of being made by the General Government.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

Digitized by Google

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Respectfully forwarded to the Chief of Engineers.

For reasons stated herein I do not think "Bayou Black, for connection between Calcasieu Lake and Sabine Lake, Louisiana," worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
Division Engineer.

S 22.

PRELIMINARY EXAMINATION OF BAYOU TECHE, LOUISIANA, FROM SAINT MARTINSVILLE TO PORT BARRE.

[Printed in House Ex. Doc. No. 280, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 24, 1891.

SIR: I have the honor to submit the accompanying copy of report, dated January 28, 1891, from Capt. W. L. Fisk, Corps of Engineers, giving results of preliminary examination of Bayou Teche from St. Martinsville to Port Barre, La., made to comply with provisions of the river and harbor act approved September 19, 1890.

Captain Fisk expresses the opinion that the improvement is worthy of being made if reliable access to markets would be given to the section of country interested; but the Division Engineer, Col. C. B. Comstock, Corps of Engineers, thinks that this reach of Bayou Teche is not worthy of improvement by the United States. I concur in the views of Colonel Comstock.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF CAPTAIN W. L. FISK, CORPS OF ENGINEERS.

OFFICE UNITED STATES ENGINEER,
New Orleans, La., January 28, 1891.

GENERAL: I have the honor to submit the following report upon preliminary examination of "Bayou Teche from St. Martinsville to Port Barre, La."

The examination was made by Assistant Engineer Thomson, to whose report (copy herewith) reference is respectfully made for description and statistics.

The value of the annual outward tonnage at present market rates is considerably over $1,000,000, and if the expenditure of $5,000, as recommended by Mr. Thomson, or even ten times that amount, will give

Digitized by Google

that section reliable access to market it is, in my opinion, an improvement worthy of being made, but to get sufficient data for a reliable estimate of cost, and to determine the effect upon the lower bayou of the low dam suggested, a survey in considerable detail will be necessary, and I estimate that $2,000 will be required for this purpose.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

BRIG. GEN. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, February 16, 1891.

Respectfully forwarded to the Chief of Engineers.

With the information at present available I do not think Bayou Teche, from St. Martinsville to Port Barre, worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *January 27, 1891.*

SIR: I respectfully submit the following report of my examination of Bayou Teche from St. Martinsville to Port Barre:

The distance from St. Martinsville to Port Barre is stated by persons familiar with the stream to be about 55 miles. The bayou is navigable throughout its entire length whenever the Mississippi River reaches a stage that is 10 feet above low water at New Orleans, as at such times the water flows freely into the Teche from the Courtableau.

Assuming such a stage of water the depths at various points would be as follows:

	Feet.
Port Barre	5
Leonville	3
Arnouldville	8
Breaux Bridge	8
St. Martinsville	10

This is the least stage of water that would render the navigation practicable at all times.

To secure it and at the same time preserve the connection with the Courtableau would require the construction of two locks, one at St. Martinsville and the other at Port Barre.

At Arnouldville, 32 miles above St. Martinsville, the Bayou Fusilier empties into the Teche. This is a short stream, not more than 3 miles in length, and is a fork of Bayou Bourbeux, which latter is the source of Bayou Vermillion.

The Bourbeux was formerly an outlet of the Courtableau, leaving the latter a distance above the Teche, and forms the outlet for the drainage of a large portion of the parish of St. Landry. The lower portion of the Bourbeux has become much obstructed, and, as a consequence, the flow down the Fusilier is constant and large. It is, I think, enough to supply the proposed slackwater navigation.

A very serious objection to the construction of the proposed locks is found in the existence of large drainage ditches, by which all the rainfall is thrown into the Teche. Should the proposed improvement be made and the current destroyed, there would be a bar formed at the mouth of each of these ditches which in a few years would seriously interfere with navigation.

Digitized by Google

Between St. Martinsville and Port Barre there are about 40 of these ditches.

A swell of 8 feet, from excessive rains, is not uncommon in the Upper Teche.

I can see nothing in the interests involved to justify the expenditure required for the locks. It is true the country is extremely fertile, is well populated, and the area in cultivation is expanding largely every year; also, that they are now compelled either to haul the crops and supplies to and from the railroad or wait for the annual rise in the Mississippi.

The great complaint of the people is the uncertainty of their communications. When the weather is bad the roads are impassable, and the crops can not be moved before the bayou rises.

I think the best solution for this question would be to build a low-water dam at St. Martinsville of such height as to back the water to Leonville; this could easily be done at an expense of $5,000.

St. Martinsville has always been considered as the head of navigation for large steamers; in fact they have recently declined to go above New Iberia.

At the present time the crops from both above and below St. Martinsville are brought to that point in barges and transferred to the railroad.

The construction of a low-water dam would interfere but slightly with the current and not at all with the traffic. It would give all the upper portion of the Teche permanent and reliable means of communication and fully meet all present and future demands.

STATISTICS.

The area of the country tributary to the Upper Teche is well settled and extends for several miles back from the stream. It produces annually about as follows:

Cotton	bales..	13,500
Cotton seed	tons..	6,000
Sugar	hogsheads..	9,300
Rice	barrels..	11,000

This constitutes the outward tonnage. The inward, consisting of lumber and family supplies, is correspondingly large.

In my opinion, unless some measures are adopted for closing the drainage canals and preventing the leaving of sunken logs in the bayou, it will not be many years before the Teche will cease to be a navigable stream.

Any improvement which does not include a remedy for these two evils would be a waste of money.

Herewith please find map to accompany this report.*

Very respectfully,

P. H. THOMSON,
Assistant Engineer.

Capt. W. L. FISK,
Corps of Engineers, U. S. A.

S 23.

PRELIMINARY EXAMINATION OF BAYOU DES GLAISES, LOUISIANA, WITH A VIEW OF CLEARING THE STREAM OF OBSTRUCTIONS FROM THE ATCHAFALAYA RIVER TO COTTONPORT.

[Printed in House Ex. Doc. No. 119, Fifty-first Congress, second session.]

OFFICE UNITED STATES ENGINEER,
New Orleans, La., November 29, 1890.

GENERAL: I have the honor to submit the following report upon preliminary examination of "Bayou des Glaises, Louisiana, with a view of clearing the stream of obstructions from the Atchafalaya River to Cottonport."

The obstructions which are most dangerous to steamboats navigating Bayou des Glaises are overhanging trees, and most of them are found

*Not reprinted.

Digitized by Google

distributed over six different portions of the Bayou, aggregating about 16 miles in length.

There are also many snags and logs in the bed, but when navigable at all there is sufficient water in the bayou for boats to pass safely over them, so they are not considered of importance by those using the stream.

I estimate the cost of removing and securing the overhanging trees at $2,500.

No survey will be required.

The outward-bound commerce, naturally tributary to Bayou des Glaises, is approximately as follows: 25,000 bales of cotton, 12,000 tons of cotton seed, 3,000 tons sugar, cattle, lumber, etc.; about 21,000 tons, of a value of about $1,500,000.

Inward-bound freight is estimated at about 10,000 tons more, mostly provisions.

I am of the opinion that this improvement is worthy of being made.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 17, 1890.

Respectfully forwarded to the Chief of Engineers.

I think Bayou des Glaises worthy of improvement to the extent proposed by the district officer.

C. B. COMSTOCK.
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

S 24.

PRELIMINARY EXAMINATION OF BAYOU VERMILLION, BAY AND PASSES, LOUISIANA.

[Printed in House Ex. Doc. No. 273, Fifty-first Congress, second session.]

OFFICE UNITED STATES ENGINEER,
New Orleans, La., January 20, 1891.

GENERAL: I have the honor to submit the following report upon preliminary examination of Bayou Vermillion, bay and passes, Louisiana.

This examination was made by Assistant Engineer P. H. Thomson, whose report (copy herewith) is so complete there remains little more to say, and reference to it is respectfully made for description of the stream, the various obstructions to navigation existing, and statistics.

The value of the sugar, molasses, cotton, and rice of this year's crop is over $800,000, and if the in freights are of equal value, as estimated, the total annual traffic amounts to considerably more than $1,500,000,

Digitized by Google

In my opinion this showing is sufficient to warrant improvement to such an extent as to allow 5½ feet of water to be carried up to the crossing of the Southern Pacific Railroad.

I estimate roughly that this work will cost $25,000; no further survey will be required unless Congress decides to undertake the improvement.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, February 16, 1891.

Respectfully forwarded to the Chief of Engineers.

I concur with the district engineer in the opinion that Bayou Vermillion, bay and passes, is worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, *January 17, 1891.*

SIR: I respectfully submit the following report of my examination of Bayou Vermillion and Passes, with accompanying map.*

BAYOU VERMILLION.

This stream, rising in the parish of St. Landry, flows in a southerly direction for a distance of approximately 90 miles to its mouth, where it empties into the bay of the same name. It may be said to be navigable for its entire length, as all parts of it have been used for the transportation of crops and supplies, but the construction of Morgan's Railroad across the upper portion has caused an entire cessation of all traffic above the crossing.

The facilities offered by the railroad have also caused the withdrawal of the steamers on that portion of the bayou extending from the railroad to Sebastopol Coulee. In consequence there has been no effort made to keep the bayou clear of obstructions, and it is now in such condition that where formerly boats drawing from 4 feet could easily pass up to Pinhook (the landing for La Fayette) they can not now get above the Sebastopol Coulee.

The obstructions consist of logs and overhanging timber.

From Sebastopol Coulee to Vermillion Bay boats drawing 5½ feet can at all times freely pass, so far as the stage of water is concerned. The bayou has a very uniform width of about 100 feet until it passes Abbeville and from that point it gradually widens to the mouth, where the width is about 400 feet. For the last 7 miles it flows through the sea marsh.

After leaving Sebastopol Coulee the first obstruction is Broussard's Bridge. The only fault to be found with it is the location, it being in a short bend, and when a steamer is in the draw her bow and stern are both in the bushes on the banks. The location is inexcusable, as by going up the stream 350 feet the bridge could have been placed in a straight reach. There is no special danger in passing the bridge, but it causes great delay, especially when there is any wind.

* Not reprinted.

Digitized by Google

The next serious obstruction is the bridge at Abbeville. This is so dangerous that I have thought it best to make the accompanying plan, by reference to which you will see how badly a structure can be located.

To illustrate how it works I will describe the passage down of the steamer *E. H. Barmore*, on the 11th, at which time I was on her. The *Barmore* is 34 feet beam, the clear span of the draw is 55 feet, but in order to protect the bridge piles have been driven in the span (see plan) which reduces the opening to about 40 feet. When the *Barmore* blew her whistle the bridge was placed parallel with the current, she was headed directly for the pivot pier and swung against the upper part of the bridge, which was turned with her until it assumed the position shown by the dotted lines. As the current was very strong, the river being very high, her guards caught on some of the piles in front of the pivot pier and were badly broken; she hung on the piles until they were sawed off, and then floated down until her bow touched the bank on the west bank, when the bridge was again turned as she passed through.

The depth of water in the bayou at this point is about 12 feet at low tide, and this depth extends from one bank to the other. As you will see, when the draw is parallel to the current there is not more than 32 feet opening, 2 feet less than the beam of the *Barmore*.

The bridge itself is a miserable affair, a wooden Howe truss, and about worn out. It will soon be necessary to repair it or build a new one.

Certainly the location should be changed so as to place the structure at right angles to the stream.

The next serious obstruction is the hull of the steamboat *Exchange*, which lies about 2 miles below Abbeville. The forward and after decks remain intact, but the middle of the hull has been broken up, leaving the ribs of the vessel at low tide exposed. This wreck is peculiarly dangerous, and the snag which sunk the boat projects from the bank on the opposite side not more than 100 feet above it. The relative position of snag and wreck make this a particularly dangerous obstruction.

There is another drawbridge at Perry's Bridge, but the river is straight and the opening ample.

At Rose Hill plantation, some 15 miles below Abbeville, is a sunken coal barge loaded with coal, but it is probable that the owner will attempt to recover the coal and cut up the barge for fuel.

Between Sebastapol Coulee and the mouth of the bayou there are about 50 snags which should be removed. Many of these are just below the surface at low water and are never visible.

The bar extends from the mouth of the Bayou to Buck Point, a distance of about three-quarters of a mile. It is soft mud, and the steamers by always passing in one place have made a channel through, pushing the mud up on each side. At ordinary high water there is not more than 5 feet on this bar, but the mud is so soft that the steamer can push through at least 1 foot of it.

From Buck Point out into Vermillion Bay at a point north of Red Fish Point the usual depth will not exceed 5½ feet. From this point to the Gulf through Southwest Pass there is fully 10 feet. A line drawn from Red Fish Point to Cypremort Point would pass over a very extensive shoal, which is bare at low water.

I have shown by a dotted line on the accompanying map the course taken by the steamers from Vermillion to Morgan City.

In passing between Bird and Marsh Islands the water is not more than 5½ feet in depth. After passing Bird Island it is about 8 feet to Bayou Sole Bay, where it deepens to a depth of 18 feet. There is another shoal just north of Morrison Cut-off with 5½ feet, but in the cut-off itself the depth is 10 feet and upwards, and this depth continues to the open water outside. This examination was asked for by persons living on the Vermillion with the hope to have the stream opened at the upper end, that they might have some certain and speedy means of communication.

A very forcible example of the uncertainty of the present route has just occurred, as the only steamer now running broke down and was unable to deliver the freights. When we reached the bayou they were out of supplies; in fact some of the merchants had hauled temporary supplies of groceries from New Iberia. The passage from Morgan City is always attended with risk of delay, either from the weather or low water.

ESTIMATE.

The obstructions from La Fayette to Sabastopol Coulee are said by the pilots of the small boats which run there to consist of fallen trees, over which there is not more than 2 feet of water. It was impossible for me to count them, as they were all submerged, but collating the opinions of men familiar with the navigation it would be safe to place the necessary figures at $5,000.

For the remainder of the bayou removing snags and wrecks would require $5,000. To drive piles to mark the channel from mouth of Bayou Vermillion to Vermillion Bay proper, a distance of about 5 miles, $1,500. It would very materially assist nav-

Digitized by Google

igation on this route to drive heavy piles every quarter of a mile to mark the channel, as there are numerous reefs in the bays. The electric headlight would show the piles at that distance. This work, if done, would require an expenditure of about $2,000.

STATISTICS.

Shipments for crop of 1890–'91 will amount in round numbers to—

Sugar	hogsheads..	5,000
Molasses	barrels..	6,000
Cotton	bales..	10,000
Rice	barrels..	20,000

There is a large trade in domestic produce, such as eggs, chickens, hogs, etc., which, with the cattle, closely approximate in amount the articles above enumerated.

The in-freights are said to fully equal in value those going out.

The country is rapidly improving, and during the coming season the acreage sown in cane and rice will be doubled.

I think the improvement fully worthy of the attention of the Government, as there are no present or proposed means of communication other than by water.

Very respectfully,

P. H. THOMSON,
Assistant Engineer.

Capt. W. L. FISK,
Corps of Engineers, U. S. A.

S 25.

PRELIMINARY EXAMINATION OF MERMENTON [MERMENTAU] RIVER, LOUISIANA, INCLUDING ITS TRIBUTARIES AND COURSE THROUGH LAKE ARTHUR AND GRAND LAKE TO THE GULF OF MEXICO.

OFFICE U. S. ENGINEER,
New Orleans, La., January 10, 1891.

GENERAL: I have the honor to submit the following report on the preliminary examination of "Mermenton River, including its tributaries and course through Lake Arthur and Grand Lake to the Gulf of Mexico."

The examination was made by Assistant Engineer P. H. Thomson, copies of whose very interesting report and sketches are herewith, and to which reference is respectfully made for description and statistics.

The name of the stream is given as Mermenton in the act authorizing the examination and on some maps, but others give it as Mermentau, and by this latter name it is generally known.

Mr. Thomson's report clearly shows that with its tributaries it is a stream of considerable capacity and importance, and I am of the opinion that a careful examination should be made, including a survey of the bar at the mouth, and of such other portions of the river and tributaries as may be necessary to obtain sufficient data for a reliable estimate of the cost of the improvement required.

Mr. Thomson's estimates of $1,000 for a line of piling to mark the channel at the lower end of Grand Lake, and $20,000 for removing obstructions in the Nezpiqué are only rough approximations, as there has not been sufficient money available to attempt more.

I estimate that the survey will cost $1,200.

Very respectfully, your obedient servant,

W. L. FISK,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

Digitized by Google

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, January 13, 1891.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated I think the Mermentau and its tributaries worthy of improvement in some small degree. The amount of improvement which is justifiable can only be determined after more definite information as to its cost and the amount of existing commerce.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A., Division Engineer.

REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

LAKE ARTHUR, LA., *December 9, 1890.*

SIR: I submit the following report of my examination of the Mermentau River and its tributaries:

MERMENTAU RIVER.

This stream is formed by the junction of Bayou Cane and Bayou Plaquemine Brulé, and the point of junction is about 5 miles above the town of Mermentau, a station on the Southern Pacific Railway. Its general direction is southwest and the following table will afford an idea as to its several parts and their relative distances:

	Miles.
From head of river to Mermentau	7
From Mermentau to Lake Arthur	22
Through Lake Arthur	10
Lake Arthur to Grand Lake	13
Through Grand Lake	14
Grand Lake to Upper Mud Lake	12
Through Upper Mud Lake	2
Upper Mud Lake to Grand Chenier	4
Grand Chenier to Lower Mud Lake	2
Lower Mud Lake to mouth of river	8
Total length of Mermentau River	94

These distances are as given to me by persons engaged in navigating the river, captains and pilots of steamers, etc.

The Mermentau throughout its entire course is never less than 400 feet in width and frequently like other tidal streams expands to four times that distance. In the river proper the depth varies from 15 to 50 feet.

There are a few snags, but the stream is so large, and their position so well known, that they can scarcely be called obstructions to navigation. In case of the lakes the situation is different.

LAKE ARTHUR.

This lovely sheet of water has an average depth of water of 20 feet. It has bold banks on all sides, and all of the land south of the lake is planted with orange groves.

The lake has an average width of 1 mile, is not straight, and there are several islands of timber. There is an extensive mud flat where the river leaves the lake, but in the channel there is never less than 8 feet of water. There are a few dangerous snags in this lake which are dangerous in dark or stormy weather.

GRAND LAKE.

Is about 10 miles north and south and 20 miles east and west in extent. It has an average depth of about 8 feet, except at the lower end, where occurs the only serious obstacle to the interior navigation of the Mermentau. This consists of a mud flat extending for three-quarters of a mile and having on it not more than 4 feet of water.

Digitized by Google

The mud is very soft, and if the streams could confine themselves to one channel, would soon be washed away. The steamboat men have several times staked out the channel for this purpose, but the fishermen pull up the stakes for firewood. The river men think if the Government would officially place stakes to mark the channel they would not be disturbed. To drive a row of piles for that purpose would not cost more than $1,000.

From Grand Lake to the bar at the mouth of the river there is never less than from 8 to 9 feet in the channel.

MOUTH OF THE RIVER.

I sounded the bar carefully at low water and got no soundings of less than 5 feet. The channel across the bar is about as wide as the average width of the river, 1,000 feet, and the distance between the 8-foot curves is about 1 mile.

The 8-foot curve on the outside is approximately 2 miles from the mouth and 1 mile due south from the nearest land.

The course of the river is about S. 75° W., the general trend of the coast line being nearly N. 80° W., bearings all magnetic.

To the eastward of the channel and bar, and all the way from the mouth of the river to the 8-foot curve outside, is a reef composed of hard dark clay, having upon it at low water not more than 2 feet of water. It forms a natural jetty and appears at one time to have been above the tide.

The bar is composed largely of the same material, but in spots is very soft. It has some mud lumps, as I am informed by seamen familiar with it, but I did not succeed in finding them.

I inclose herewith a rough sketch of the bar and mouth of the river (not drawn to scale).

The Coast Survey has not reached this point since the war, the last beacon, placed about four years since, being some 6 miles eastward.

This bar can be readily and economically improved, as the course from the mouth of the river to sea leads with the current directly over the bar, and the reef on the windward side would form the best of foundations for any improvement as it is composed of exceedingly hard and very tenacious material.

TRIBUTARIES OF THE MERMENTAU RIVER.

The tributaries of the Mermentau are all of them called bayous. They are navigable as follows:

	Miles.
Bayou Cane	10
Bayou Plaquemine Brulé	20
Bayou Nezpiqué	60
Bayou Queue Tortue	20
Bayou Lacasine	50
Add Mermentau River	94
Total navigable waters of river and tributaries	254

All these are tidal streams and have their sources, or rather terminal points, in large cypress swamps. While steamers occasionally go up all of them for the distances named, with one exception, it is never for any purpose other than to tow out timber.

Bayous Cane, Plaquemine Brulé, Queue Tortue, and Lacasine are sufficiently clear of obstructions to meet all requirements of the present. Bayou Nezpique occupies a different position and requires a more extended notice.

BAYOU NEZPIQUE.

The head of navigation of this bayou is near Youngs Ferry, which is not far from the line between the parishes of St. Landry and Acadia. It extends thence for an estimated distance of 60 miles to its junction with the Mermentau, at a point on the latter 3 miles above the town of Mermentau. At its head it is about 80 feet wide and 15 feet deep, which width and depth it maintains for 25 miles to Millersville; thence to Jenckes Mill, about 20 miles, it gradually widens until it attains a width of 300 feet, which it maintains to its mouth.

From Millersville down it has not less than 25 feet of water at all times.

From the mouth up to Jenckes Mill this bayou is comparatively free from obstruction. There are some snags and a few overhanging trees, but the stream is wide enough to avoid them. From Jenckes Mill to the head of navigation the obstructions are numerous and dangerous, consisting of snags, logs, fallen trees, and over-

Digitized by Google

hanging timber. There are also two bridges, one of which seriously obstructs navigation and the other stops it altogether.

These bridges are located, one at Jenckes Mill, 15 miles from Mermentau, and the other at Viterboville, 40 miles from the same town.

The bridge at Jenckes was built by the parish of Calcasieu and has a draw, so called. It is located at an angle with the stream, and the passage through the draw is extremely dangerous during any flood in the river. There are no fender piles to guide the boats, and if it was not that the boats must be tied up before they can pass accidents would certainly happen. They are compelled to tie up their boats, take the crew and tackle, and open the draw, as no one has been placed in charge to do so for them. The mechanism for opening and closing the draw is incomplete and very primitive.

The draw-span at right angles to the bridge is only 24 feet. It is true that is large enough to pass any boat now on the bayou, but another and larger one is only awaiting the completion of the railway draw at Mermentau to pass up.

The entire bridge is of a flimsy character and should be removed.

The other bridge is at Viterboville, 40 miles from Mermentau, who built it for his own use, to force custom to his store and warehouse by making it the head of navigation. It is a permanent pile trestle, with a center span of 24 feet, which Viterbo proposes to convert into a sliding draw when forced to do so. If this bridge was removed the boats could go many miles further up the stream.

It is as well here for me to call your attention to the bridge over the Mermentau now building by the Southern Pacific Railway Company.

The work of placing this draw was commenced in June last, and although the superstructure has been in place for more than a month, the false work has not been removed nor the draw made ready for use.

The owners of the steamer plying on the lower river are anxious to extend her trips up the Nezpique, where many thousand sacks of rice await transportation, and the delay is causing them serious inconvenience and pecuniary loss.

The Nezpique is crooked beyond expression. In many places it is not more than 100 feet across a bend, while the distance around is more than a mile.

In all these instances that I noticed it would be preferable, both for economy and the interests of navigation, to make the cut-offs, especially as, being a tidal stream, ordinarily with no current, there would be no caving or washing of the banks. The highest floods known do not exceed 14 feet above tide water.

The banks of the Nezpique are well defined, and the water is as deep near them as in the center of the stream.

Roughly, I estimate the cost of removing the obstructions in the Nezpique at $20,000.

STATISTICS.

I have found it extremely difficult to arrive at satisfactory data as to the commerce of the Mermentau and its tributaries.

There are at present three steamers, two running up the Nezpique from Mermentau, and one, much larger, running from the same place to Grand Chenier.

There are numerous schooners and large sloops which carry cotton, hides, lumber, and oranges from the lower river to Galveston.

All the steamers tow barges and carry full loads at this season, principally rice, cotton, cattle, and oranges. During the summer they are constantly employed transporting lumber and building material of all kinds, brick, lime, sand, etc.

The production of rice on the Nezpique is very great, taxing the transportation facilities to the utmost. If the stream was freed from obstructions so that large boats could be placed in the trade, I think it would in one year be more than trebled.

From Millersville to Youngs Ferry there will be placed in market from the country within a few miles of the Nezpique not less this year than 50,000 barrels of clean rice, and more than three times as many acres of rice will be grown the coming year. The country is fertile, the farmers are mostly homesteaders, and rice is the best crop they can raise.

On the Lower Mermentau it is out of my power to obtain more than vague and unsatisfactory figures, but it is safe to put the annual tonnage, inward and outward, at about 10,000 tons.

It is at best a guess, as so much goes direct from the place where raised by sea to Galveston and Orange, Tex.

I think the Mermentau and Bayou Nezpique are worthy of more detailed examination than permitted by my orders.

Very respectfully,

P. H. THOMSON,
Assistant Engineer.

Capt. W. L. FISK,
Corps of Engineers.

Digitized by Google

SURVEY OF MERMENTON RIVER, LOUISIANA, INCLUDING ITS TRIBUTARIES AND COURSE THROUGH LAKE ARTHUR AND GRAND LAKE TO THE GULF OF MEXICO.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 13, 1891.

GENERAL: I have the honor to make the following report upon the survey of the Mermenton River, including its tributaries and course through Lake Arthur and Grand Lake to the Gulf of Mexico, Louisiana:

A survey party was organized and sent to the point where the Southern Pacific Railroad crosses the Mermenton River. A quarterboat was hired at this point in April, 1891, and the party was towed up the Nezpique Bayou to Viterboville, the head of navigation at present on this the principal tributary of the Mermenton River.

The survey was commenced 6.2 miles above Viterboville and extends to the mouth of the Mermenton River, a distance by water of 94 miles; the portion of the Mermenton above the junction of the Nezpique was not surveyed, since it is deemed unimportant at present.

The country through which the survey extended is very fertile and is being rapidly settled, the commerce of the region is rapidly increasing, and the improvement of the river is necessary to afford the requisite facilities to reach the markets without excessive cost for transportation.

The river to within a short distance of the Gulf is of good depth and width, and the principal improvement required is the removal of snags and impending trees.

From the head of Grand Lake to the Gulf numerous mud flats occur, some of which might be removed by the construction of brush dams, which would concentrate the current and scour out the channels.

The mouth of the river is obstructed with a bar.

The cost of improving the river from Viterboville to the mouth is estimated at $23,615.25. The cost of jetties at the mouth, to give deep water over the bar, is estimated at $781,210.

There has been expended in making this survey the sum of $1,508.64.

COMMERCIAL STATISTICS.

It has not been possible to obtain precise statistics of the commerce of this river. The products of the country tributary to this stream are lumber, rice, sugar, fruits, hogs, cotton, cattle, and corn. There are three steamers navigating the Mermenton and Nezpique, and several large schooners and sloops carry the produce of the lower river to the westward. All the steamboats tow barges and carry full loads. Larger boats are urgently needed to meet the present demands, and it is believed that with the river improved so that larger boats could be used, the transportation by water would more than double in a short time. Mr. P. H. Thomson, assistant engineer, estimates the value of the exports at about $750,000 per annum, and the imports at about the same.

The report of Mr. Thomson is appended, and the maps* of the survey are herewith.

Respectfully submitted.

JAMES B. QUINN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

*Not printed.

Digitized by Google

REPORT OF MR. P. H. THOMSON, ASSISTANT ENGINEER.

NEW ORLEANS, La., *July 23, 1891.*

SIR: I have the honor to submit the following report of the survey of the Mermenton River, with accompanying map:

The Mermenton, as shown on the published maps, is formed by the junction of Bayou Cane and Bayou Plaquemine Brulee, at a point about 2 miles above the mouth of Bayou Nezpique. The latter is the true river and will be so considered in this report.

I moved my party to Viterboville, intending to go further up the river, but found the latter so obstructed that it was impossible to take the quarter boat above that point. I pushed the survey, however, to a point 6.2 miles above, when I found it impossible to proceed, even in small boats, on account of the obstructions. It was evident that to render this portion of the Nezpique navigable would entail an expense altogether out of proportion to the benefits to be derived from the improvement.

In this report I have considered Viterboville as the head of navigation. Small steamers run constantly to that point.

The distance in an air line from Viterboville to the mouth of the Mermenton is about 53 miles. The length of the stream as determined by the survey is 94 miles.

WIDTHS.

The stream at Viterboville is 70 feet wide and maintains the same width for a distance of 7 or 8 miles, when it begins to gradually widen until at the mouth of the Nezpique it attains a width of 250 feet. From that point to Lake Arthur the Mermenton is generally 350 feet wide, rarely less and often more. The entire stream from Viterboville to the Gulf of Mexico is purely tidal and like all similar rivers has many wide bays and eddies.

Above Lake Arthur the banks are precipitous, and there is deep water the full width of the river. From Shell Beach to the Gulf, especially where the stream is wide, there occur extensive mud flats.

Lake Arthur has a width in several places of more than a mile, with a deep-water channel of some 800 feet in width.

From Lake Arthur to Grand Lake the width is from 700 to 1,000 feet.

There is no channel through Grand Lake, the depth being very uniform. I have indicated the course taken by the steamers by arrows on the map, which show that it skirts the western shore of the lake, keeping in water 6 feet deep.

From Grand Lake to the Gulf of Mexico the river has a uniform width of channel of about 400 feet. It passes through two mud lakes, which, at low water, are bare of water for the greater part.

No description can so clearly show the varying widths of the river as can be gathered from an inspection of the accompanying map.

TIDES.

The effect of the tides are readily perceived at all points from Viterboville to the Gulf, but the currents caused by them are very slight above Lake Arthur. Below that lake they run full and strong.

DEPTHS.

At Viterboville, and for a distance of 5 miles below that point, the least depth found was 7 feet; thence to Lake Arthur the depth varies greatly, but is never less than 30 feet; in many places it is 60 feet.

Through Lake Arthur the channel has a minimum depth of 7 feet. From Lake Arthur to Grand Lake the minimum depth is 24 feet. Through Grand Lake the uniform depth is 6 feet.

In the river immediately below Grand Lake the river is 30 feet deep, but the depth from that point to the mouth gradually decreases. At the mouth inside the depth is 13 feet.

About 5 miles above the mouth, at the head of a lake, occurs a shoal, through which I found a channel of 7 feet available for steamers, but too crooked for sailing vessels, which can not carry more than 5 feet over the flats.

All the soundings here given and on the map are referred to mean low tide in the Gulf, not with perfect accuracy, but with a close approximation thereto.

BRIDGES.

There are bridges at Viterboville, Jenkes Mill, and Mermenton.

The bridge at Viterboville is a slight trestle with no draw, but being at the head of navigation no change of structure is required.

Digitized by Google

The bridge at Jenkes Mill is also a trestle, with a sliding draw-span of 24 feet opening. This bridge is badly located, being at an angle of 60° with the current at high water. There are no guide-piles and no bridge tender. Whenever the steamers wish to pass they are compelled to open the draw themselves. The opening is large enough for the vessels at present navigating the stream, but should any improvements be made in the river above, much larger steamers are ready to enter the trade and the bridge must then be remodeled.

The bridge at Mermenton is of iron and belongs to the Southern Pacific Railway, which here crosses the river. It has a draw with a clear opening of 38 feet, which is large enough.

GENERAL FEATURES.

From Viterboville to Lake Arthur the river lies in a narrow valley, which is heavily timbered and most of which is a swamp, the banks not being more than 2 feet out of water. The stream meanders through this valley, touching at short intervals the high lands on either side. There is no current in this part of the river and the influence of the tides is only marked by their rise and fall. The average width of this valley is about 1 mile.

Outside the valley the country is an open prairie, whose height above the water at Viterboville is 40 feet, and whose surface falls very regularly southward, until at the mouth of the Mermenton it is about 2 feet above mean low water.

From Viterboville to the lower end of Lake Arthur all the land is either in cultivation or else preparations are being made to put in crops during the coming year.

From Lake Arthur to the Gulf the country is an open prairie, with numerous high ridges, which latter all have a heavy growth of live-oak trees upon them. In places the land is so low that it becomes marshy, but it can be readily reclaimed and placed in cultivation. At present all this portion is devoted to cattle ranges and orange groves.

DRAINAGE AREA.

The Mermenton drains about 2,300 square miles, but as a large portion of this is located in the pine woods, where the soil is sandy, the rainfall does not run off very rapidly.

FRESHETS.

The extreme rise at Viterboville is 15 feet, and 2 feet at Grand Chenier. From the peculiar formation of the valley these freshets cause but little damage until the water reaches the low lands near the coast, which they cover to the depth of a few inches only.

STATISTICS.

Nothing is more difficult than to obtain satisfactory statistics of the production of any particular country where there are several outlets for the trade and no records especially kept.

The country tributary to the Mermenton River ship their produce in three different ways—by steamer and barge to Mermenton, by wagon to Jennings and other stations on the railroad, and by schooners to Galveston and other points. The products shipped to market are rice, cotton, cattle, hogs, horses, and oranges and other fruits.

Any estimate would at best be a guess, but from the best information I could obtain, I think it would be far within bounds to put the exports at $750,000 per annum and the inward tonnage at about the same amount, the latter consisting of supplies, machinery, and agricultural implements.

There are seven large saw mills on the river, but all the lumber is used at home and much more brought from Lake Charles and Morgan City.

OBSTRUCTIONS.

These consist of snags, logs, and overhanging trees in the upper river and a mud flat in the lower.

Between Viterboville and Mermenton Station there are 582 snags and logs and 2,835 overhanging trees to be removed from the river.

Between Mermenton Station and the lower end of Lake Arthur there are 21 snags in the river and lake, which are dangerous at night and in bad weather. From Lake Arthur to the head of the lower Mud Lake below Grand Chenier, the river is clear. The obstruction at lower Mud Lake consists of a mud flat, which can readily be removed by the construction of a brush dam which would concentrate the action of

Digitized by Google

the current. The bar at the mouth constitutes the only remaining obstruction, and of that I will treat in another paragraph.

To remove all the obstructions from the head of navigation to the bar at the mouth of the river I submit the following:

ESTIMATE.

Removing 603 snags and logs, at $10	$6,030.00
Removing 2,835 overhanging trees, at $3	8,505.00
Brush dam at lower Mud Lake, 1,000 cords brush, at $6	6,000.00
Engineering, 15 per cent	3,080.25
Total for river	23,615.25

MERMENTON BAR.

The entrance into the Mermenton River from the Gulf of Mexico, which is shown on the map as it was in June, 1891, has not occupied its present position for many years. When the buoy was placed outside some 6 years ago vessels sailed direct from it into the mouth of the river. Now a very extensive shoal has formed directly in this course and the entrance is from an entirely different quarter.

The distance from the buoy to the mouth of the river is 11,140 feet. The buoy is located in water 15 feet deep. The depth outside increases very rapidly, and masters of vessels assured me they had frequently anchored in 5 fathoms of water within a mile of the buoy. It is said the 30-foot curve approaches nearer the land at the Mermenton than at any other point on the coast.

On the bar proper there is a depth at mean low water of 5 feet, the distance across the bar being 800 feet and the width of the channel 400 feet. The bottom is hard clay with soft spots.

Masters of vessels familiar with this bar report that it is now at least 1,500 feet further out than it was 20 years ago, and that all the reefs and shoals have formed in that time. The depth of water on the bar is said to have increased in that time at least 2 feet, it being then not more than 3 feet at low water.

The depth in the river at this point is 13 feet.

To give the same depth through the bar would necessitate the building of a jetty to the 15-foot curve outside.

The peculiar angle which the river makes with the prevailing westerly currents would render necessary the construction of one jetty only. The following estimate is based upon a jetty having a crown of 10 feet, built 2 feet above high water, and having slopes of two horizontals to one perpendicular. It also includes the regular foundation mattress. Full allowance has been made for subsidence.

ESTIMATES.

Total length of jetty, 11,140 feet.

Square yards of mattress, 56,800, at $3	$170,400
Cubic yards of rock, 122,162, at $5	610,810
Total cost	781,210

Very respectfully.

P. H. THOMSON,
Assistant Engineer.

Maj. JAMES B. QUINN,
Corps of Engineers, U. S. A.

Digitized by Google

Digitized by Google

APPENDIX T.

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING, AND REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION OF NEW ORLEANS HARBOR, LOUISIANA.

REPORT OF LIEUTENANT JOHN MILLIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

IMPROVEMENTS.

1. Securing mouth of Bayou Plaquemine, Louisiana, from further caving.
2. Removing sunken vessels or craft obstructing or endangering navigation of New Orleans Harbor, Louisiana.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 3, 1891.

GENERAL: I have the honor to submit the following report upon the works in charge of this office under the Chief of Engineers, U. S. Army, for the year ending June 30, 1891.

I reported here for duty on October 11, 1890, in obedience to Special Orders No. 202, dated Headquarters of the Army, Adjutant-General's Office, August 29, 1890; and my predecessor in charge of the office, Capt. Dan C. Kingman, Corps of Engineers, U. S. Army, after visiting with me all the various works, left for his new station on November 4, 1890.

* * * * * * *

Very respectfully, your obedient servant,

JOHN MILLIS,
First Lieutenant of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

T 1.

SECURING MOUTH OF BAYOU PLAQUEMINE, LOUISIANA, FROM FURTHER CAVING.

This bayou was formerly a diffluent or outflowing branch of the Mississippi River. It left the River at the town of Plaquemine, La., and emptied into Grand Lake, but in 1865 a levee or dike was built across

Digitized by Google

the bayou at Plaquemine, thus severing its connection with the Mississippi and terminating its functions as an outlet.

By the river and harbor act of August 11, 1888, an appropriation was made for securing a navigable channel in this bayou up to the dike at Plaquemine and preventing further caving of the bank of the Mississippi at the "mouth" (head) of the bayou.

The construction of a system of locks to afford navigable entrance to the Bayou from the Mississippi is understood to be in contemplation. The work of bank protection was placed in charge of this office by letter of May 15, 1889, from the Chief of Engineers, owing to the fact that the Mississippi River Commission plant belonging to the fourth district, Mississippi River, would thereby be available for doing the work at such time as it would not be otherwise occupied. The sum of $75,000 was allotted for this part of the work.

The approved project under which this sum was to be expended contemplated the building of four large submerged spur dikes with sloping crests running out at right angles to the shore. These dikes were to be built of willow brush, timber, and stone, in accordance with the general method of construction adopted by the Mississippi River Commission for that class of work in this part of the river, the shore end of each spur to extend up to low water, and from that point a spur levee built of earth was to run to the main levee. The portion of this levee below high-water line was to be covered with a layer of gravel and then a layer of stone. Four of the dikes were to be built with the funds available; two above the bayou and two below, at intervals of about 900 feet.

At the date of the last annual report the upper two of these dikes, Nos. 1 and 2, had been built, but as the work was completed during a high stage of the river and was soon after subject to an unusual flood, the eastern spur levees were somewhat injured, though the efficiency of the work does not seem to have been materially impaired thereby, and there was no serious caving in the vicinity.

No construction work has been done during the past year. The locality has been examined from time to time and there appears to have been no caving or erosion of the bank of any consequence since the dikes were built.

On November 3, 1890, this office was informed by the Chief of Engineers of the allotment of $60,000 from the appropriation of September 19, 1890, for continuing the work and directions given for the preparation of a project accordingly.

There were no indications of necessity for immediately continuing the work, and it was not practicable to make the examinations and surveys necessary to prepare a project at that season, owing to the stage of the river and the urgent demands of other work, and it was therefore deemed best to defer the surveys and preparation of the project until after the next flood season. The facts were reported accordingly. Moreover, the plant for doing the work was occupied elsewhere for the entire season, so it would not have been possible in any case to begin construction work till the next low-water season.

Six thousand three hundred and forty-eight tons of rock for continuing the work has been brought from the quarries near Harrisonburg, La., and placed on the bank opposite Plaquemine. The survey necessary to the preparation of the project will soon be commenced.

NOTE.—The money statement for this work is consolidated with that for the improvement of Bayou Plaquemine, La., Appendix S 6.

Digitized by Google

COMMERCIAL STATISTICS FOR PLAQUEMINE, LOUISIANA.

Statement showing total receipts and shipments of freight by boat, compiled from information received from Commercial Exchange, steamboat landing, and stores where the boats receive and discharge cargoes.

Total cargo received	tons..	61,110
Total value of same		$819,176.00
Total cargo shipped	tons..	57,899
Total value of same		$596,899.00
Total cargo received and shipped	tons..	119,009
Total value of same		$1,416,075.00

The above refers to the Mississippi River commerce only, and does not include commerce on the Bayou Plaquemine.

T 2.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION OF NEW ORLEANS HARBOR, LOUISIANA.

On September 5, 1890, notice was issued from this office in compliance with section 4 of the river and harbor act of June 14, 1880, regarding the following sunken wrecks in the harbor:

Vallette Dry Dock and ship *Isle Marthe*, lying near the right bank of the river off Algiers Point, just above the Morgan Line Docks. The elevator *Leo Gilchrist*, lying near the left bank at Terpsichore street.

The steamboat *Edward J. Gay*, lying on the left bank at First street.

These vessels were all wrecked in 1888, and the wrecks all lay near the wharves and were serious obstructions to navigation at the water front.

Advertisement was issued for the removal of all these wrecks on November 29, 1890, and the following bids were opened on December 30, 1890, viz:

No.	Name of bidders.	Place of business.	Bids received.		
			Vallette dry dock and ship Isle Marthe.	Elevator Leo Gilchrist.	Steamboat Edward J. Gay.
1	William H. Brown	New Orleans, La.	None	$1,225	$1,500
2	McDonald & Usner	do	None	2,600	2,100

The proposal of Mr. Wm. H. Brown (No. 1) was accepted, contract entered into and the work begun, the contract requiring its completion by March 26, 1891.

The removal of the *Leo Gilchrist* was reported completed on March 3, 1891, and the contractor's plant transferred to and work begun on the *Edward J. Gay*. Considerable delay occurred in prosecuting the work, as at that season every available wharf is needed by vessels loading with cotton, and blasting operations were interrupted on account of danger of injury to ships in the vicinity. Finally the rising river stopped the work entirely and the time of completing the contract was extended first to June 1, 1891, and afterwards to June 20, 1891.

No formal bids were received for removing the *Vallette Dry Dock* and ship *Isle Marthe*, though McDonald & Usner, after recommendation was

Digitized by Google

made for the acceptance of Mr. Brown's bid for the others, offered to remove the third wreck for $4,300. This was considered excessive, and on April 15, 1891, proposals were again invited for removing the wreck of the dry dock and ship.

The following bids were opened on May 15, 1891:

Name of bidders.	Place of business.	Amount.
Charles W. Johnston	Lewes, Del	$2, 3[illegible]
John W. Glenn	New Orleans, La	2. [illegible]
Ethan A. Burriss	do	3. [illegible]
Peter Keveny and James Moore	do	3. [illegible]
Peter Usner and John W. McDonald	do	5. [illegible]
William H. Keates	Somers Point, N. Y	5. [illegible]

The bid of Mr. Charles W. Johnson was recommended for acceptance and contract entered into for completing the work by August 10, 1891.

Both of the foregoing contracts have been completed, and I have to report that the harbor of New Orleans is now clear of obstructions to navigation of this character.

Digitized by Google

APPENDIX U.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN TEXAS.

REPORT OF MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1891, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Entrance to Galveston Harbor, Texas.
2. Ship channel in Galveston Bay, Texas.
3. Trinity River, Texas.
4. Cedar Bayou, Texas.
5. Buffalo Bayou, Texas.
6. Harbor at Brazos Santiago, Texas.

EXAMINATIONS.

7. Mouth of Double Bayou, in Chambers County, Texas, to remove obstructions.
8. Trinity River, Texas, from its mouth to Dallas.
9. Colorado River, Texas, with a view of removing raft at mouth of same.
10. Aransas Bay, Texas, to remove Half-Moon Reef; and Saint Charles Bay, Texas, with a view of removing obstructions at mouth of same.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., July 6, 1891.

GENERAL: I have the honor to transmit herewith the annual reports for the works under my charge for the fiscal year ending June 30, 1891.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF ENTRANCE TO GALVESTON HARBOR, TEXAS.

The project for this improvement was adopted in 1874, modified in 1880, and again modified in 1886, the object being to deepen the channel so as to admit of sea-going vessels of the deepest draft entering the harbor.

Digitized by Google

The projects of 1874 and 1881 contemplated construction of two jetties to extend into the Gulf of Mexico to concentrate ebb flow upon the outer bar in the Gulf and also to effect deepening on the inner bar at the entrance to Galveston Channel. These jetties to have their origins, respectively, at Bolivar Point and Fort Point.

More or less work was done under those projects; under that of 1881 a jetty was built from Fort Point to the crest of the outer bar, but it was not fully completed.

The project of 1886 (that now in progress of execution) also consists in construction of jetties to extend into the Gulf, one, the south jetty, starting from the east end of Galveston Island, and the other, the north jetty, to start from Bolivar Point, opposite. Or, to be more exact, the south jetty was to start from Fort Point, but in 1888 it was decided to connect the inner end of that jetty with the relatively high ground upon which the city of Galveston is built, by a stone dike known as the shore branch.

The jetties are to be of rock, to be built to an elevation of 5 feet above mean low tide, and to extend, if necessay, to the contour of 30-foot depth in the Gulf, their sea ends to be 7,000 feet apart. The action of the jetties to be supplemented, if need be, by dredging. The south jetty to follow the line of the jetty of 1881.

The natural depth upon the outer bar was 12 feet, and that upon the inner bar 13 feet at mean low tide. The general plan of the work is shown upon the accompanying map.

At the close of the fiscal year ending June 30, 1890, there had been constructed 19,200 linear feet of south jetty, of which 1,200 feet were incomplete. The railway trestle had been extended 428 feet beyond the rock work. The railway is used for transporting material to be deposited in the jetty.

The effect of the work at the close of that year was found in a depth of 13½ feet upon the outer, and 21 feet upon the inner bar.

The work of construction during the past fiscal year ceased August 30 last. The work was done by contract with A. M. Shannon & Co. The contract was dated October 13, 1888, and was to have been completed June 30, 1889. It was extended as to time to December 31, 1889; again extended to June 30, and still further extended to August 30, 1890. All additional expense caused to the United States by the extensions was deducted from sums due the contractors for work performed.

The work of construction accomplished during the past fiscal year resulted in an extension of the rock work 350 feet, of which 150 feet are incomplete, and in extension of the trestle and track 240 feet further.

In addition, 1,200 linear feet of work not entirely finished at the close of the preceding fiscal year were completed.

At the close of the contract the condition of the work was as follows:

Linear feet of jetty completed	19,400
Linear feet of jetty incomplete	150
Total linear feet of rock work complete and incomplete	19,550
Linear feet of trestle and track beyond the incompleted rock work	318

About 4,000 cubic yards of small rock and spalls were distributed along the shore branch for the purpose of making it more water-tight, and a few car loads of rock were also placed at the south end of the branch to insure firmer connection with the island.

Immediately after completion of the contract, and again in January

Digitized by Google

and February last, longitudinal profiles and cross sections of the work were taken in order to ascertain the extent, if any, of change in form of the structure. No great amount of settlement was observed.

In May and June last the usual annual survey was made of the outer bar and its channel, and of the harbor generally, to include Bolivar Gorge and the Galveston Channel as far as Forty-first street. The soundings were reduced to the plane of reference used for the survey of April, May, and June, 1890. They show a depth of 13¼ feet in the outer bar channel, and a depth of 21 feet on the inner bar. The movement of contours since the survey of 1890 was made has been as follows:

On the harbor side of the outer bar the positions of the 12-foot and 30-foot contours are practically unchanged. The 18-foot and 24-foot contours have receded somewhat. On the Gulf side of the bar there has been some advance of the 12-foot, 18-foot, 24-foot, and 30-foot contours.

The 13¼-foot channel is straighter and slightly wider than it was last year. For a detailed description of the work of the past year, reference is made to the report hereto appended of Mr. E. M. Hartrick, assistant engineer.

The tidal observations in Galveston Bay and at the harbor entrance were continued. Seven self-registering tide gauges were under observation and their records were plotted. For a full account of these gauges and comparison and discussion of their records, attention is invited to the report herewith of Lieut. Wm. C. Langfitt, Corps of Engineers.

In March, 1890, running a line of precise levels to connect the zeros of the tide gauges with each other and with the permanent bench-mark on the Hendley building at Galveston was commenced. The spring of 1890 was one of floods for the rivers discharging into Galveston Bay, so that the work of connecting bench-marks at Galveston with those on Boliver Point had to be carried on across Bolivar Gorge, an extremely difficult undertaking. Connections were made, however, with the gauge at Hanna Reef, though under great disadvantage on account of frequent interruptions from boisterous weather. Connection was also made with the tide gauge at the north side of Bolivar Gorge. The field work stopped July 10.

The leveljng should be connected with the zero of the tide gauge on the outer bar, about 3 miles out from the shore, and the zeros of the tide gauges at Red-Fish Bar should be connected with each other. Such observations as had been made were worked up in the office as time permitted. It was in contemplation to resume the leveling in February or March last to the extent, at least, of connecting the zeros of the Red-Fish Bar gauges with each other, but as it was found impracticable to do so at that time, and as it could not then be determined when leveling could be resumed, the leveling instruments were returned to the Mississippi River Commission, which had kindly lent them to this office. The Commission had need of leveling instruments. An account in detail of the precise leveling work is contained in the report herewith of Mr. Gerald Bagnall, assistant engineer.

It appears from comparison of the levels, so far as taken, with records of the Bolivar Gorge, Government Wharf, and Hanna Reef tide-gauges that Professor Mitchell's rule for determining differences of elevation of zeros of tide gauges by means of simultaneous readings of the gauge at time of the slack waters can be relied upon as sufficiently close for use in Galveston Bay when the gauges to be compared have similar hydrographical surroundings.

Digitized by Google

The evidence of the applicability of this rule as noted enables us to considerably reduce the work of precise leveling required in Galveston Bay.

Discussions of the comparisons between calculations by Mitchell's rule and results of precise leveling is contained in Lieutenant Langfitt's report, already mentioned.

A large amount of mapping, revision of estimates, etc., has been done by the office force during the year.

Congress, by act approved September 19, 1890, appropriated as follows:

Improving entrance to Galveston Harbor, Texas: Continuing improvement, five hundred thousand dollars: *Provided*, That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the plan contained in the report of the Chief of Engineers for Eighteen hundred and eighty-six for the improvement of that harbor, to be paid for as appropriations may from time to time be made by law.

Proposals, to be opened December 27, 1890, for performing the work were invited by public advertisement of 60 days.

At the opening of proposals the lowest bid, that of John H. Mooney and Augustine M. Newton, of New York, was accepted for constructing railway, including trestle, and for furnishing sandstone riprap and granite blocks in place. (Please see abstract of proposals, A, herewith.) Mooney and Newton failed to enter into the required contract, and, in consequence, the work was readvertised February 28, under the same specifications as before, proposals to be opened March 30. The contract for constructing railway, including trestle, and for furnishing sandstone riprap and granite blocks in place was awarded to O'Connor, Laing & Smoot, of Dallas, Tex., they being the lowest bidders for the aggregate of the three items. (See abstract of proposals, B, herewith.)

The contract was approved June 2 last.

Congress, by act approved March 3, 1891 (sundry civil bill), appropriated the sum of $600,000 for continuing the improvement, thus making $1,100,000, less contingencies of inspection and engineering, available for the work.

It is proposed to commence work under the contract in extending the south jetty. By the terms of the contract delivery of material must begin not later than August 1 next.

A small force of contractors' men commenced June 29 upon repairs to the existing track on the jetty in order to admit of construction trains passing over it.

For the statement of shipments from Galveston, contained in the table of commercial statistics for the year ending June 30, 1890, hereto appended, I am indebted to Mr. Julius Runge, president of the Galveston Cotton Exchange. For the number, character, and tonnage of vessels entered and cleared for the same period acknowledgment is due Mr. N. W. Cuney, collector of the port. The statistics for this work and others in charge of this office were compiled by Mr. Elliott Jones, chief clerk.

The comparative tables of statistics herewith, to which attention is invited, show that the shipments of cotton have increased from 853,000 bales or 223,486 tons in 1890 to 1,114,133 bales or 258,638 tons in 1891, and that the total tonnage of vessels entered and cleared has increased from 964,372 tons in 1890 to 1,073,920 tons in 1891, a net increase of 109,548 tons.

Total expended on the improvement under all projects to June 30, inclusive, 1890	$2,158,847.41
Expended on the present project to June 30, 1890	680,944.39
Expended on the project to June 30, 1891	796,017.88

Digitized by Google

Digitized by Google

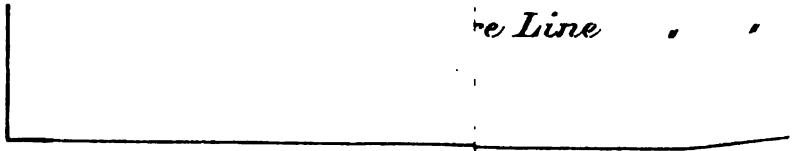


Photo-Lith. by A. HOEN & CO., Balto., Md.

Digitized by Google

The contract entered into is for the entire work, and, according to its terms, the work, including delivery of material in place, must be vigorously pushed at such rate that the contractors shall earn not less than $1,000,000 per year, provided appropriations to that extent or at that rate are made by Congress.

It is recommended that the sum of $1,000,000 be appropriated for the fiscal year ending June 30, 1893, for continuing the improvement, most, if not all, of which sum to be applied to work on the projected north jetty.

Originally estimated cost of the work as revised in 1886	$8,478,000
Aggregate amount appropriated to July 1, 1891	3,378,000
Total amount expended	2,273,920

In addition to this there was expended the sum of $100,000 subscribed by the city of Galveston in 1883.

The work is located in the collection district of Galveston. The nearest lighthouses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1891, was $174,489.92.

Abstract of appropriations made by Congress for improving harbor at Galveston, Tex.

By act approved—	
July 11, 1870	*$25,000
March 3, 1871	*20,000
June 10, 1872	*31,000
June 23, 1874	60,000
March 3, 1875	150,000
August 14, 1876	142,000
June 7, 1878	75,000
June 18, 1878	50,000
March 3, 1879	100,000
June 14, 1880	175,000
March 3, 1881	250,000
March 4, 1882	100,000
By act passed August 2, 1882	300,000
By act approved August 5, 1886	300,000
By act of August 11, 1888	500,000
By act approved September 19, 1890	500,000
By act approved March 3, 1891	600,000
Total	3,378,000

Money statement.

July 1, 1890, balance unexpended		$119,152.59
Amount appropriated by act approved September 19, 1890		500,000.00
Amount appropriated by sundry civil act approved March 3, 1891		600,000.00
		1,219,152.59
June 30, 1891, amount expended during fiscal year		115,073.49
July 1, 1891, balance unexpended		1,104,079.10
July 1, 1891, outstanding liabilities	$2,372.63	
July 1, 1891, amount covered by uncompleted contracts	†1,040,000.00	
		1,042,372.63
July 1, 1891, balance available		61,706.47

Amount (estimated) required for completion of existing project ... 5,100,000.00

Amount that can be profitably expended in fiscal year ending June 30, 1893 ... 1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

*These appropriations were mostly expended in small dredging operations prior to the adoption of the project of 1874.

†Sixty thousand dollars reserved from the appropriations of September 19, 1890, and March 3, 1891, for contingencies of engineering and inspection.

Digitized by Google

A.—*Abstract of proposals for improving entrance to Galveston Harbor, Texas, received in response to advertisement dated October 25, 1890, and opened by Maj. Chas. J. Allen, Corps of Engineers, at Galveston, Tex., December 27, 1890.*

Articles.	Tons.	1. Barney Lantry, Strong City, Kans.		2. Edward H. Gaynor, Boston, Mass.		3. John H. Mooney, Augustine M. Newton, New York, N. Y.	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
In the south jetty:							
Sandstone riprap	220,000	$2.39	$525,800	$3.15	$693,000	$2.00	$440,000
Sandstone blocks, ½ to 1 ton each	1,000	2.39	2,390	3.15	3,150	2.00	2,000
Sandstone blocks, 1 to 2 tons each	1,000	2.39	2,390	3.30	3,300	2.15	2,150
Sandstone blocks, 2 to 5 tons each	1,000	2.59	2,590	3.50	3,500	2.20	2,200
Sandstone blocks, 5 to 10 tons each	105,000	2.79	292,950	4.50	472,500	2.35	246,750
Concrete blocks, 5 to 10 tons each	105,000	.....	.....	4.95	519,750	4.00	420,000
Sandstone blocks, 10 tons and over, each	7,000	3.35	23,450	5.20	36,400	2.50	17,500
Concrete blocks, 10 tons and over, each	7,000	.....	.....	5.25	36,750	4.00	28,000
Granite riprap	220,000	3.91	860,200	4.70	1,034,000	3.40	748,000
Granite blocks, ½ to 1 ton each	1,000	4.00	4,000	4.70	4,700	3.40	3,400
Granite blocks, 1 to 2 tons each	1,000	4.00	4,000	4.90	4,900	3.40	3,400
Granite blocks, 2 to 5 tons each	1,000	4.20	4,200	4.90	4,900	3.60	3,600
Granite blocks, 5 to 10 tons each	105,000	4.40	462,000	4.90	514,500	4.00	420,000
Concrete blocks, 5 to 10 tons each	105,000	.....	.....	4.95	519,750	4.00	420,000
Granite blocks, 10 tons and over, each	7,000	4.96	34,720	5.25	36,750	4.00	28,000
Concrete blocks, 10 tons and over, each	7,000	.....	.....	5.25	36,750	4.00	28,000
In the north jetty:							
Sandstone riprap	518,000	2.72	1,408,960	2.85	1,476,300	2.10	1,087,800
Sandstone blocks, ½ to 1 ton each	2,200	2.72	5,984	2.85	6,270	2.10	4,620
Sandstone blocks, 1 to 2 tons each	35,000	2.72	95,200	3.00	105,000	2.20	77,000
Sandstone blocks, 2 to 5 tons each	49,000	2.92	143,080	3.00	147,000	2.25	110,250
Sandstone blocks, 5 to 10 tons each	82,000	3.12	255,840	4.50	369,000	2.45	200,900
Concrete blocks, 5 to 10 tons each	82,000	.....	.....	4.75	389,500	4.00	328,000
Sandstone blocks, 10 tons and over, each	75,000	3.68	276,000	4.90	367,500	2.50	187,500
Concrete blocks, 10 tons and over, each	75,000	.....	.....	5.00	375,000	4.00	300,000
Granite riprap	518,000	4.33	2,242,940	4.40	2,279,200	3.40	1,761,200
Granite blocks, ½ to 1 ton each	2,200	4.33	9,526	4.40	9,680	3.40	7,480
Granite blocks, 1 to 2 tons each	35,000	4.33	151,550	4.50	157,500	3.60	126,000
Granite blocks, 2 to 5 tons each	49,000	4.53	221,970	4.60	225,400	3.60	176,400
Granite blocks, 5 to 10 tons each	82,000	4.73	387,860	4.60	377,200	4.00	328,000
Concrete blocks, 5 to 10 tons each	82,000	.....	.....	4.65	381,300	4.00	328,000
Granite blocks, 10 tons and over, each	75,000	5.13	384,750	4.70	352,500	4.00	300,000
Concrete blocks, 10 tons and over, each	75,000	.....	.....	5.00	375,000	4.00	300,000
	Feet.						
Railway and trestle	34,500	4.23	145,935	4.00	138,000	3.60	124,200
Total for sandstone and railway		.....	3,180,569	.....	3,820,920	.....	2,502,870
Total for granite and railway		.....	4,913,651	.....	5,139,230	.....	4,029,680

Articles.	Tons.	4. N. H. Ricker, president Southern Construction Co., Galveston, Tex.		No. 5. Jno. F. O'Connor, Joseph Laing, Edgar K. Smoot, Dallas, Tex.	
		Price.	Amount.	Price.	Amount.
In the south jetty:					
Sandstone riprap	220,000	$2.71	$596,200	$2.95	$649,000
Sandstone blocks, ½ to 1 ton each	1,000	2.71	2,710	2.95	2,950
Sandstone blocks, 1 to 2 tons each	1,000	2.71	2,710	3.00	3,000
Sandstone blocks, 2 to 5 tons each	1,000	2.71	2,710	3.15	3,150
Sandstone blocks, 5 to 10 tons each	105,000	4.52	474,600	3.40	357,000
Concrete blocks, 5 to 10 tons each	105,000	7.50	787,500	8.55	897,750
Sandstone blocks, 10 tons and over, each	7,000	4.52	31,640	3.75	26,250
Concrete blocks, 10 tons and over, each	7,000	7.50	52,500	8.75	61,250
Granite riprap	220,000	4.52	994,400	7.25	1,595,000
Granite blocks, ½ to 1 ton each	1,000	4.52	4,520	7.25	7,250
Granite blocks, 1 to 2 tons each	1,000	4.52	4,520	7.40	7,400
Granite blocks, 2 to 5 tons each	1,000	4.52	4,520	7.60	7,600
Granite blocks, 5 to 10 tons each	105,000	4.52	474,600	7.75	813,750
Concrete blocks, 5 to 10 tons each	105,000	7.50	787,500	11.35	1,191,750
Granite blocks, 10 tons and over, each	7,000	4.52	31,640	8.00	56,000
Concrete blocks, 10 tons and over, each	7,000	7.50	52,500	11.50	80,500

Digitized by Google

A.—*Abstract of proposals for improving entrance to Galveston Harbor, etc.*—Continued.

Articles.	Tons.	4. N. H. Ricker, president Southern Construction Co., Galveston, Tex.		No. 5. Jno. F. O'Connor, Joseph Laing, Edgar K. Smoot, Dallas, Tex.	
		Price.	Amount.	Price.	Amount.
In the north jetty:					
Sandstone riprap	518,000	$2.96	$1,533,280	$2.95	$1,528,100
Sandstone blocks, ½ to 1 ton each	2,200	2.96	6,512	2.95	6,490
Sandstone blocks, 1 to 2 tons each	35,000	2.96	103,600	3.00	105,000
Sandstone blocks, 2 to 5 tons each	49,000	2.96	145,040	3.15	154,350
Sandstone blocks, 5 to 10 tons each	82,000	4.77	391,140	3.40	278,800
Concrete blocks, 5 to 10 tons each	82,000	7.50	615,000	8.55	701,100
Sandstone blocks, 10 tons and over, each	75,000	4.77	357,750	3.75	281,250
Concrete blocks, 10 tons and over, each	75,000	7.50	562,500	8.75	656,250
Granite riprap	518,000	4.77	2,470,860	7.25	3,755,500
Granite blocks, ½ to 1 ton each	2,200	4.77	10,494	7.25	15,950
Granite blocks, 1 to 2 tons each	35,000	4.77	166,950	7.40	259,000
Granite blocks, 2 to 5 tons each	49,000	4.77	233,730	7.60	372,400
Granite blocks, 5 to 10 tons each	82,000	4.77	391,140	7.75	635,500
Concrete blocks, 5 to 10 tons each	82,000	7.50	615,000	11.35	930,700
Granite blocks, 10 tons and over, each	75,000	4.77	357,750	8.00	600,000
Concrete blocks, 10 tons and over, each	75,000	7.50	562,500	11.50	862,500
	Feet.				
Railway and trestle	34,500	3.90	127,650	4.55	156,975
Total for sandstone and railway			3,775,542		3,552,316
Total for granite and railway			5,272,774		8,282,325

Bid No. 1, accompanied by letter qualifying bid on sandstone. Bid No. 3, lowest, acceptance recommended for sandstone riprap, granite blocks and railway. Amount available, $500,000 (less office and inspection expenses), appropriated by act of September 19, 1890.

B.—*Abstract of proposals for improving entrance to Galveston Harbor, Texas, received in response to advertisement dated February 28, 1891, and opened by Maj. Charles J. Allen, Corps of Engineers, at Galveston, Tex., March 30, 1891.*

Articles.	Tons.	1. Samuel Hawks, New York.		2. John P. Nelson, San Antonio.		3. B. Lantry & Sons, Strong City, Kans.	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
In the south jetty:							
Sandstone riprap	220,000	$2.70	$594,000	$2.39	$525,800	$2.47	$543,400
Sandstone blocks, ½ to 1 ton each	1,000	2.70	2,700	2.40	2,400	2.47	2,470
Sandstone blocks, 1 to 2 tons each	1,000	2.70	2,700	2.45	2,450	2.47	2,470
Sandstone blocks, 2 to 5 tons each	1,000	2.70	2,700	2.50	2,500	2.47	2,470
Sandstone blocks, 5 to 10 tons each	105,000	3.00	315,000	4.51	473,550	2.47	259,350
Concrete blocks, 5 to 10 tons each	105,000	4.57	479,850	7.00	735,000	2.47	259,350
Sandstone blocks, 10 tons and over each	7,000	3.25	22,750	4.65	32,550	2.47	17,200
Concrete blocks, 10 tons and over each	7,000	4.57	31,990	7.50	52,500	4.75	33,250
Granite riprap	220,000	4.57	1,005,400	4.40	968,000	3.65	803,000
Granite blocks, ½ to 1 ton each	1,000	4.57	4,570	4.51	4,510	4.11	4,110
Granite blocks, 1 to 2 tons each	1,000	4.57	4,570	4.51	4,510	4.11	4,110
Granite blocks, 2 to 5 tons each	1,000	4.57	4,570	4.51	4,510	4.11	4,110
Granite blocks, 5 to 10 tons each	105,000	4.57	479,850	4.51	473,550	4.60	483,000
Concrete blocks, 5 to 10 tons each	105,000	4.57	479,850	7.00	735,000	4.60	483,000
Granite blocks, 10 tons and over each	7,000	4.57	31,990	4.65	32,550	4.60	32,200
Concrete blocks, 10 tons and over each	7,000	4.57	31,990	7.50	52,500	4.60	32,200
In the north jetty:							
Sandstone riprap	518,000	2.40	1,243,200	2.45	1,269,100	2.47	1,279,460
Sandstone blocks, ½ to 1 ton each	2,200	2.40	5,280	2.45	5,390	2.47	5,434
Sandstone blocks, 1 to 2 tons each	35,000	2.40	84,000	2.55	89,250	2.47	86,450
Sandstone blocks, 2 to 5 tons each	49,000	2.90	142,100	2.60	127,400	2.47	121,030
Sandstone blocks, 5 to 10 tons each	82,000	3.00	246,000	4.61	378,020	2.47	202,540
Concrete blocks, 5 to 10 tons each	82,000	4.30	352,600	7.00	574,000	2.47	202,540
Sandstone blocks, 10 tons and over each	75,000	3.25	243,750	4.75	356,250	2.47	185,250
Concrete blocks, 10 tons and over each	75,000	4.30	322,500	7.50	562,500	4.75	356,250

Digitized by Google

B.—*Abstract of proposals for improving entrance to Galveston Harbor, etc.*—Continued.

Articles.	Tons.	1. Samuel Hawks, New York.		2. John P. Nelson, San Antonio.		3. B. Lantry & Sons, Strong City, Kans.	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
In the north jetty—Continued.							
Granite riprap	518,000	$4.27	$2,211,860	$3.75	$1,942,500	$3.81	$1,973,580
Granite blocks, ¾ to 1 ton each	2,200	4.27	9,394	4.61	10,142	4.27	9,394
Granite blocks, 1 to 2 tons each	35,000	4.27	149,450	4.61	161,350	4.27	149,450
Granite blocks, 2 to 5 tons each	49,000	4.27	209,230	4.61	225,890	4.27	209,230
Granite blocks, 5 to 10 tons each	82,000	4.27	350,140	4.61	378,020	4.74	388,680
Concrete blocks, 5 to 10 tons each	82,000	4.27	350,140	7.50	615,000	4.74	388,680
Granite blocks, 10 tons and over each	75,000	4.27	320,250	4.70	352,500	4.74	355,500
Concrete blocks, 10 tons and over each	75,000	4.27	320,250	7.55	566,250	4.74	355,500
	Lin. feet.						
Railway and trestle	34,500	4.00	138,000	3.95	136,275	4.10	141,450
Total for sandstone and railway			3,042,180		3,400,935		2,849,064
Total for granite and railway			4,919,274		4,694,307		4,557,814
Total for sandstone riprap granite blocks, and railway			3,539,214		3,578,707		3,604,094
Total for sandstone riprap and blocks under 2 tons, granite blocks 2 tons and over, and railway			3,465,910		3,497,685		3,533,854

Articles.	Tons.	4. Henry Bennett, Topeka, Kans.		5. John F. Gaynor, Fayetteville, N. Y.	
		Price.	Amount.	Price.	Amount.
In the south jetty:					
Sandstone riprap	220,000	$2.30	$506,000	$2.75	$605,000
Sandstone blocks, ¾ to 1 ton each	1,000	2.30	2,300	3.20	3,200
Sandstone blocks, 1 to 2 tons each	1,000	2.30	2,300	3.30	3,300
Sandstone blocks, 2 to 5 tons each	1,000	2.49	2,490	3.50	3,500
Sandstone blocks, 5 to 10 tons each	105,000	2.68	281,400	4.50	472,500
Concrete blocks, 5 to 10 tons each	105,000	4.40	462,000	5.00	525,000
Sandstone blocks, 10 tons and over each	7,000	3.24	22,680	5.00	35,000
Concrete blocks, 10 tons and over each	7,000	4.75	33,250	5.00	35,000
Granite riprap	220,000	3.76	827,200	4.70	1,034,000
Granite blocks, ¾ to 1 ton each	1,000	3.84	3,840	4.70	4,700
Granite blocks, 1 to 2 tons each	1,000	3.84	3,840	4.70	4,700
Granite blocks, 2 to 5 tons each	1,000	4.06	4,060	4.70	4,700
Granite blocks, 5 to 10 tons each	105,000	4.23	444,150	4.70	493,500
Concrete blocks, 5 to 10 tons each	105,000	4.40	462,000	5.50	577,500
Granite blocks, 10 tons and over each	7,000	4.78	33,460	4.70	32,900
Concrete blocks, 10 tons and over each	7,000	4.75	33,250	6.00	42,000
In the north jetty:					
Sandstone riprap	518,000	2.63	1,362,340	2.45	1,269,100
Sandstone blocks, ¾ to 1 ton each	2,200	2.63	5,786	3.00	6,600
Sandstone blocks, 1 to 2 tons each	35,000	2.63	92,050	3.00	105,000
Sandstone blocks, 2 to 5 tons each	49,000	2.82	138,180	3.00	147,000
Sandstone blocks, 5 to 10 tons each	82,000	3.00	246,000	4.50	369,000
Concrete blocks, 5 to 10 tons each	82,000	4.73	387,860	5.00	410,000
Sandstone blocks, 10 tons and over each	75,000	3.57	267,750	5.00	375,000
Concrete blocks, 10 tons and over each	75,000	5.00	375,000	6.00	450,000
Granite riprap	518,000	4.09	2,118,620	4.40	2,279,200
Granite blocks, ¾ to 1 ton each	2,200	4.09	8,998	4.40	9,680
Granite blocks, 1 to 2 tons each	35,000	4.09	143,150	4.40	154,000
Granite blocks, 2 to 5 tons each	49,000	4.29	210,210	4.40	215,600
Granite blocks, 5 to 10 tons each	82,000	4.40	358,180	4.40	360,800
Concrete blocks, 5 to 10 tons each	82,000	4.73	387,860	5.00	410,000
Granite blocks, 10 tons and over each	75,000	5.00	375,000	4.40	330,000
Concrete blocks, 10 tons and over each	75,000	5.00	375,000	6.00	450,000
	Lin. feet.				
Railway and trestle	34,500	3.99	137,655	4.00	138,000
Total for sandstone and railway			3,066,931		3,532,200
Total for granite and railway			4,678,364		5,061,780
Total for sandstone riprap, granite blocks, and railway			3,600,881		3,622,680
Total for sandstone riprap and blocks under 2 tons and granite blocks 2 tons and over, and railway			3,543,491		3,567,700

Digitized by Google

B.—*Abstract of proposals for improving entrance to Galveston Harbor, etc.*—Continued.

Articles.	Tons.	6. Ricker, Lee & Co., Galveston, Tex.		7. O'Connor, Laing & Smoot, Dallas, Tex.	
		Price.	Amount.	Price.	Amount.
In the south jetty:					
Sandstone riprap	220,000	$2.70	$594,000	$2.45	539,000
Sandstone blocks, ½ to 1 ton each	1,000	2.70	2,700	2.50	2,500
Sandstone blocks, 1 to 2 tons each	1,000	2.70	2,700	2.55	2,550
Sandstone blocks, 2 to 5 tons each	1,000	2.70	2,700	2.65	2,650
Sandstone blocks, 5 to 10 tons each	105,000	3.00	315,000	2.75	288,750
Concrete blocks, 5 to 10 tons each	105,000	5.00	525,000	5.00	525,000
Sandstone blocks, 10 tons and over each	7,000	3.00	21,000	2.80	19,600
Concrete blocks, 10 tons and over each	7,000	5.00	35,000	5.25	36,750
Granite riprap	220,000	4.00	880,000	4.00	880,000
Granite blocks, ½ to 1 ton each	1,000	4.20	4,200	4.05	4,050
Granite blocks, 1 to 2 tons each	1,000	4.20	4,200	4.10	4,100
Granite blocks, 2 to 5 tons each	1,000	4.20	4,200	4.15	4,150
Granite blocks, 5 to 10 tons each	105,000	4.75	493,500	4.25	446,250
Concrete blocks, 5 to 10 tons each	105,000	5.25	551,250	6.00	630,000
Granite blocks, 10 tons and over each	7,000	4.70	32,900	4.40	30,800
Concrete blocks, 10 tons and over each	7,000	5.25	36,750	6.25	43,750
In the north jetty:					
Sandstone riprap	518,000	2.50	1,295,000	2.45	1,269,100
Sandstone blocks, ½ to 1 ton each	2,200	2.50	5,500	2.50	5,500
Sandstone blocks, 1 to 2 tons each	35,000	2.50	87,500	2.55	89,250
Sandstone blocks, 2 to 5 tons each	49,000	2.50	122,500	2.65	129,850
Sandstone blocks, 5 to 10 tons each	82,000	3.00	246,000	2.75	225,500
Concrete blocks, 5 to 10 tons each	82,000	5.00	410,000	5.00	410,000
Sandstone blocks, 10 tons and over each	75,000	3.00	225,000	2.80	210,000
Concrete blocks, 10 tons and over each	75,000	5.00	375,000	5.25	393,750
Granite riprap	518,000	3.90	2,020,200	4.00	2,072,000
Granite blocks, ½ to 1 ton each	2,200	3.90	8,580	4.05	8,910
Granite blocks, 1 to 2 tons each	35,000	3.90	136,500	4.10	143,500
Granite blocks, 2 to 5 tons each	49,000	3.90	191,100	4.15	203,350
Granite blocks, 5 to 10 tons each	82,000	4.08	334,560	4.25	348,500
Concrete blocks, 5 to 10 tons each	82,000	5.25	430,500	6.00	492,000
Granite blocks, 10 tons and over each	75,000	4.08	306,000	4.40	330,000
Concrete blocks, 10 tons and over each	75,000	5.25	393,750	6.25	468,750
	Lin. feet.				
Railway and trestle	34,500	4.00	138,000	4.00	138,000
Total for sandstone and railway			3,057,600		2,922,250
Total for granite and railway			4,553,940		4,613,610
Total for sandstone riprap, granite blocks, and railway			3,542,740		3,469,710
Total for sandstone riprap and blocks under 2 tons, granite blocks 2 tons and over, and railway			3,487,660		3,408,950

Bid No. 7, lowest. Acceptance recommended for sandstone riprap, granite blocks, and railway. Amount available $1,100,000 (less office and inspection expenses), appropriated as follows: River and harbor act of September 19, 1890, $500,000; sundry civil act of March 3, 1891, $600,000.

REPORT OF FIRST LIEUTENANT WM. C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1891.

MAJOR: I have the honor to submit the following progress report on the tidal observations of Galveston Bay for the fiscal year ending June 30, 1891:

The Rollover gauge was discontinued during the latter part of January, 1891. The gauges at Hanna Reef, Red Fish South, and Red Fish North were discontinued the latter part of this month, thus leaving going at the present time the gauges at Government Wharf, the Gorge, and Bar. It is thought that sufficient record has been obtained from the other gauges, and that these three gauges, costing nothing for keepers, will furnish record of more than sufficient value to pay for the slight expense of maintenance.

The precise level party mentioned in my last report succeeded in connecting the zeros of the Gorge and Hanna Reef gauges with the adopted bench mark on the Hendley Building, thus practically conneting these two with the Government Wharf gauge.

Before presenting such data as I have been able to compile from the platted records, it will be well to state in some detail the extent of record available from

Digitized by Google

each gauge, as this varies very much from gauge to gauge. This amount for each gauge is as follows:

Round Point.—From May, 1887, to March, 1890, of which about 15 months' record is lost.

Morgan Point.—From May, 1887, to March, 1890, of which about 8 months' record is lost.

Rollover.—From May, 1887, to December, 1890, of which about 14 months' record is lost.

Red Fish North.—From July, 1889, to December, 1890, of which about 5 months' record is lost.

Red Fish South.—From July, 1889, to December, 1890, of which about 6 months' record is lost.

Hanna Reef.—From July, 1889, to December, 1890, of which about 3 months' record is lost.

Government Wharf.—From May, 1887, to December, 1890, of which about 4 months' record is lost.

Gorge.—From April, 1890, to December, 1890, of which about 1½ months' record is lost.

Bar.—From April, 1888, to December, 1890, of which about 19 months' record is lost.

The losses of records thus shown are due to stoppages of the gauges or to doubts as to the accuracy of the records either as to time or to fluctuation.

The tides have as usual been divided into three classes, called respectively the great declination tides (G. D. T.), the small declination tides (S. D. T.), and the intermediate tides occurring between these two (I. D. T.). The first class occur when the moon's declination is large and show as one large tide in the 24 hours. The second class occur near the time of the moon's nodes and show as two small tides every 24 hours. The intermediate tides are those occurring in the passage from one of these classes to the other. The result obtained by combining all the tides are also usually given (M. T.).

It is now proposed to discuss in some detail, with the aid of the precise level determinations, the values of the relative elevations, which have heretofore been assumed, of the zeros of the various gauges.

In 1872–'3 Mr. H. C. Ripley, then United States Assistant Engineer, determined by observations that the water table of the northeast corner of the Hendley building, of this city, was 6.879 feet above the plane mean low tide, and this has been the adopted plane of reference since that date, being easily established by means of the above bench mark for any gauge near the city. But when gauges were established at various points of the bay it became necessary, in order to have a uniform plane of reference, to find the elevations of their zeros referred to the adopted plane. As level lines were generally out of the question, this has usually been done by using Mitchell's rule, which is based on the assumption that the average plane of high water at any given gauge will be as much higher or lower than the plane of high water at a second gauge as its average plane of low water is lower or higher than the average plane of low water at the second gauge. In other words, it assumes that the maxima and minima at all gauges are symmetrically placed with reference to the same plane. Hence, having established this plane at any one gauge, and having given the readings of the corresponding tidal maxima and minima at the various gauges (including the known one), the determination of the elevation of the zeros becomes a simple matter. But if this assumption is not true the results from the rule will be erroneous. It becomes then a matter of importance to determine how far this rule can be trusted. The results of the precise levels give an opportunity to make this determination, partially at least. For this purpose a series of comparisons was made between the 3 gauges (Government Wharf, Gorge, and Hanna Reef) whose zeros have been connected by the level party, and the resulting corrections compared with the true corrections found by the levels. The errors thus found are compiled in the following table. But it is evident that the readings of the high and low water planes at each gauge give sufficient data for applying Mitchell's rule, if, in their determination, no tides were omitted at any of the gauges. But supposing that the omissions at the various gauges would counterbalance one another, I have applied the rule to these readings and determined the resulting errors. They are given in the table with the others specially made, the column of remarks showing whether the value was deduced from corresponding tides only, or from determination of the high and low water planes without selecting corresponding tides.

Digitized by Google

TABLE 1.—*Errors of Mitchell's rule for determining the relative elevation of zeros of tide gauges.*

Gauges compared.	Tide. G. D. T. Number of observations.	G. D. T. Error.	I. D. T. Number of observations.	I. D. T. Error.	S. D. T. Number of observations.	S. D. T. Error.	M. T. Number of observations.	M. T. Error.	Remarks.
		Feet.		*Feet.*		*Feet.*		*Feet.*	
Gorge and Government Wharf	40	−0.18	39	−0.11	52	−0.13	131	−0.14	Corresponding tides.
	62	−0.16	60	−0.12	57	−0.10	179	−0.13	Do.
Gorge and Hanna Reef	40	−0.19	39	−0.12	52	−0.01	131	−0.09	Do.
	55	−0.16	60	−0.08	59	.....	174	−0.08	Do.
	....	−0.10	.....	−0.16	.....	−0.09	.....	−0.11	H. & L. water planes.
Hanna Reef and Government Wharf	40	+0.01	39	+0.01	52	−0.13	131	−0.05	Corresponding tides.
	....	+0.02	.....	−0.04	.....	−0.05	.....	−0.03	H. & L. water planes.
	....	−0.05	.....	−0.07	.....	−0.11	.....	−0.08	Do.

An inspection of this table does not show that any one kind of tide possesses any marked superiority over the others, and that the corrections deduced from the mean of all the tides are as likely to be correct as any, for where the true correction is unknown we can not tell which tide will give the best result. It is, of course, to be expected that gauges near to each other, and those situated in relatively similar positions, will give better results than others. This influence of relative position on the result is shown by the following values obtained for the elevation of the zero of the bar gauge when compared with the three gauges named:

	Feet.
From Gorge gauge, mean of 179 observations, all tides	−0.62
From Government Wharf, mean of 179 observations, all tides	−0.49
From Hanna Reef, mean of 174 observations, all tides	−0.54

The tides used for the first two values are the same as those used in comparing the Gorge and Government Wharf, line 2, in the above table, and for the last they are the same as those used in comparing Gorge and Hanna Reef, line 4, in the above table. The first value is considered the most accurate. The accuracy of the resulting corrections also increases with the number of observations. This is illustrated by the fact that the first approximate value of the constant for the Gorge gauge was in error by 0.27 foot, and that for Hanna Reef by 0.21 foot, both being based on a comparatively small number of observations.

Applying Mitchell's rule then to those gauges whose zeros have not been connected by precise levels, and using the determined planes of mean high and low water, a new and more accurate value of the elevation of their zeros referred to the adopted plane of reference has been found. These elevations and those found by the aid of levels are given in the following table:

TABLE 2.—*Elevation of the zeros of the tide gauges in Galveston Bay referred to the adopted plane of reference.*

Gauge.	Old value of zero elevation.	New value of zero elevation.	Remarks.
	Feet.	*Feet.*	
Bar	−0.40	−0.62	By comparison with Gorge gauge.
Gorge	−2.90	−3.17	By precise levels.
Government Wharf	−3.20	−3.20	Standard.
Hanna Reef	+0.60	+0.81	By precise levels.
Red Fish South	−3.00	−2.77	By comparison with Hanna Reef and Government Wharf.
Red Fish North	−3.00	−2.76	By comparison with Red Fish South.
Morgan Point	−2.56	−2.55	By comparison with Red Fish North.
Round Point	−4.56	−4.40	Do.
Rollover	−3.24	−3.14	By comparison with Hanna Reef.

These values of course remain good only so long as the staff gauges remain at the same elevations. It therefore becomes a matter of some importance to be able to

Digitized by Google

reproduce these elevations at any time. This has been rendered possible by putting a permanent mark on or near each tide gauge house and determining its elevation referred to the adopted plane of reference, using the corrected elevations of the zeros of the gauges.

These bench-marks are as follows:

In March, 1887, at Morgan Point, a 1-inch iron rod 3 feet long was driven into the ground at the WNW. corner of the main part of John Nelson's house, the elevation of the top of which was found by Mr. H. C. Ripley, assistant engineer, to be 14.035 feet above the plane of reference; the changed value of the gauge correction makes this 14.045 feet above that plane. The house has since been moved but the rod is still there and can easily be found. On November 10, 1890, a new bench-mark was established on the opposite side of the canal by Mr. G. Bagnall, assistant engineer, on the top of the iron rod under triangulation station Morgan Point, whose elevation as determined from the first bench-mark is 14.857 feet.

At Round Point and Rollover there are permanent staff gauges attached to the piles of the gauge houses, the elevation of whose zeros are given in the above table.

At Red Fish North a copper nail was driven into the southwest pile of the gauge house and a horizontal scratch made across the head. The elevation of this score mark is 6.56 feet above the plane of reference. An exactly similar bench-mark was put on the southwest pile of the Red Fish South tide-gauge house, whose elevation is 6.62 feet above the plane of reference. Small pieces of sheet lead were tacked over them to protect them.

At Hannas Reef a galvanized-iron spike was driven into the pile of the house nearest the steps, the elevation of the score mark on the head being 3.946 feet above the plane of reference. A piece of sheet lead was tacked over the spike.

At Gorge gauge a copper nail was driven into the northwest pile, of which the elevation of the score mark on the head is 7.839 feet above the plane of reference. It is covered as the others.

At the Bar gauge a permanent bench-mark has been placed on one of the piles nearest the ladder, the elevation of which is 8.04 feet above the plane of reference. A coating of black paint was put on around the mark to protect it.

The Government Wharf gauge can always easily be connected with the bench-marks on the Hendley Building, of which there are two, the water table at the northeast corner, elevation 6.879 feet above the plane of reference, and a copper bolt let into the corner column, elevation 10.796 feet above the plane of reference.

The precise level party also established several permanent bench-marks both on Galveston Island and on Bolivar Peninsula, the elevations and descriptions of which are given in the report of Mr. G. Bagnall, assistant engineer in charge of that work.

The fundamental assumption of Mitchell's rule is, as stated above, that the same horizontal plane will lie midway between the mean high and mean low water marks at all the gauges. But this assumption has been shown to be in error by the amounts given in Table 1. Now if at the three gauges which have been connected by precise levels the elevation of a point midway between mean high and mean low water be found for the different kinds of tide and their differences taken, these should equal the errors found and thus give an excellent check on the work. In the following table such a comparison is given. The agreement is all that could be expected when the variable nature of the tides and varying effects of the wind at the different gauges are considered.

TABLE 3.—*Comparison between differences of mid-level and errors of water comparison.*

Gauges compared.	G. D. T.		I. D. T.		S. D. T.		M. T.	
	Difference of mid-level.	Error of water comparison.	Difference of mid-level.	Error of water comparison.	Difference of mid-level.	Error of water comparison.	Difference of mid-level.	Error of water comparison.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Gorge and Government Wharf	−0.18	−0.18	−0.18	−0.11	−0.13	−0.13	−0.14	−0.14
	.....	−0.16	.....	−0.12	.....	−0.10	.....	−0.13
Gorge and Hannas Reef	−0.17	−0.13	−0.17	−0.12	−0.02	−0.01	−0.08	−0.03
	.....	−0.16	.....	−0.08	.....	0.00	.....	−0.08
Hannas Reef and Government Wharf	−0.01	+0.01	−0.01	+0.01	−0.11	−0.13	−0.06	−0.05

The following table gives the same facts as given in Tables 1 and 5 of my report of last year, revised to include the results of 1890 and those from the new gauges. The quantities are the heights of mean high and mean low water planes referred to

Digitized by Google

the plane of reference and the mean fluctuation for the various classes of tide and the mean of all the tides at the various gauges.

TABLE 4.—*Mean planes of high and low water and mean fluctuation.*

Name of gauge.	G. D. T.			I. D. T.			S. D. T.			M. T.		
	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.	Mean high water.	Mean low water.	Mean fluctuation.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Bar	+2.08	−0.65	2.73	+1.84	−0.22	2.06	+1.57	+0.35	1.22	+1.83	−0.17	2.00
Gorge	+2.03	−0.21	2.24	+1.75	+0.02	1.73	+1.63	+0.64	0.99	+1.80	+0.16	1.64
Government Wharf	+1.63	+0.06	1.57	+1.53	+0.37	1.16	+1.36	+0.70	0.66	+1.49	+0.37	1.12
Hannas Reef	+1.71	+0.27	1.44	+1.49	+0.38	1.11	+1.46	+0.80	0.66	+1.56	+0.50	1.06
Rollover	+1.65	+0.11	1.54	+1.53	+0.28	1.25	+1.39	+0.54	0.85	+1.51	+0.34	1.17
Red Fish South	+1.60	+0.47	1.13	+1.51	+0.60	0.91	+1.43	+0.99	0.44	+1.51	+0.70	0.81
Red Fish North	+1.49	+0.69	0.80	+1.38	+0.72	0.66	+1.25	+0.95	0.30	+1.38	+0.78	0.60
Morgan Point	+1.29	+0.47	0.82	+1.25	+0.59	0.66	+1.10	+0.69	0.41	+1.21	+0.61	0.60
Round Point	+1.37	+0.50	0.87	+1.36	+0.62	0.74	+1.23	+0.79	0.44	+1.31	+0.65	0.66

Below is given Table 3 of my report of last year, giving the delay in high and low water, revised to include the results from the newer gauges and a new determination of the interval between the Bar and Government Wharf. The Bar time of high or low water is taken as the origin, and the intervals show how much later the corresponding phase of any tide is at the gauge considered.

TABLE 5.—*Delay in high and low water from the Bar gauge.*

Name of gauge.	Distance from Bar.	Delay in high water.				Delay in low water.			
		G. D. T.	I. D. T.	S. D. T.	M. T.	G. D. T.	I. D. T.	S. D. T.	M. T.
	Miles.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
Gorge	4	0.63	0.60	0.56	0.60	0.56	0.51	0.49	0.53
Government Wharf	6½	1.25	1.19	1.01	1.16	1.17	1.15	0.84	0.95
Hannas Reef	14½	3.24	2.77	2.44	2.80	2.89	2.66	2.29	2.51
Rollover	30	4.60	4.39	4.21	4.41	5.55	5.23	4.62	5.01
Red Fish South	16½	4.82	4.07	3.23	4.00	3.63	3.40	3.13	3.29
Red Fish North	17	7.53	6.54	4.90	6.31	5.29	4.99	4.47	4.81
Morgan Point	30¾	8.27	7.10	5.17	6.64	6.26	5.92	5.28	5.69
Round Point	35½	8.10	6.87	5.71	6.75	6.56	6.17	5.64	5.99

The figures of the last two tables call for some explanation. Taking up Table 4 first, it will be noticed that the plane of mean low tide for each different class of tides rises as we pass from the Bar to the more distant gauges, and that the fluctuation decreases at the same time. This is a natural consequence of theory arising from considerations of the depth of the bay, its form, the friction, and the fresh-water flow in it.

At all the gauges it will be noticed that the plane of mean low tide rises in elevation from that for the G. D. T. to that for the S. D. T., and that the fluctuations decrease passing the same way. While the facts necessary to explain this were given last year, it is thought better to enter into the explanation a little more in detail, even at the risk of some repetition.

At the generality of ports where the tides have been made the subject of study it is found that there is a decrease of fluctuation and a rise in height of low water when referred to a fixed plane in passing from the springs or tides occurring at or near the syzygies to the neap tides or those occurring at or near the quadratures. But the variations given in the above table are not connected at all, or, at least, but very slightly, with the relative position of the sun and moon. That this has but slight effect is shown from the following values for the bar gauge of the fluctuation at springs and neaps and the elevations of the plane of mean low tide at the same periods, what is called the diurnal inequality having been eliminated in the determination.

	Feet.
Mean fluctuation spring tide	1.37
Mean fluctuation neap tide	0.91
Elevation plane mean low tide above plane of reference, springs	0.50
Elevation plane mean low tide above plane of reference, neaps	0.62

Digitized by Google

It is to be understood that these values are but rough approximations, but they are sufficiently exact for the purpose in view, to show the comparatively small effect of the phases of the moon on the tidal phenomena at this port. Moreover, as both spring and neap tides enter into each class of tide, the tabular values will correspond to a mean tide so far as the effects depending on the phases of the moon are concerned. But the diurnal inequality stated as eliminated in the determination of the spring and neap tide fluctuations is the determining quantity in the tabular classification. This inequality has been long known, and remarked in tidal studies. The following quotation from the article on tides in the Encyclopedia Brittanica gives an idea of its nature:

"So far we have supposed the luminaries to move in the equator. Now let us consider the case where the moon is not on the equator. It is clear in this case that at any place the moon's zenith distance at the upper transit is different from her nadir distance at the lower transit. But the tide-generating force is greater the smaller the zenith or nadir distance, and, therefore, the forces are different at successive transits. Thus there is a tendency for two successive lunar tides to be of unequal heights, and the resulting inequality is called a 'diurnal tide.' * * * One of the most remarkable conclusions of Laplace's theory of the tides, on a globe covered with ocean to a uniform depth, is that the diurnal tide is everywhere nonexistent. But this hypothesis differs much from the reality, and, in fact, at some ports the diurnal tide is so large that during two portions of the lunation there is only one great high water and one great low water in each 24 hours, whilst in other parts of the lunation the usual semidiurnal tide is observed."

This latter state exists at this port, and such a condition of affairs necessarily complicates and renders extremely laborious any analysis of the tides looking to tidal prediction or astronomical calculation. After considerable study of the methods employed in such cases it is believed that for the purposes for which these tidal observations were made no useful result would be obtained by such a discussion. I have therefore limited my analysis to that amount which will explain sufficiently for my purposes the facts exhibited in the tables.

As a consequence of the quotation given above, the diurnal tide is evanescent twice in a lunar declination month, or at or near the time of the moon's nodes. For a full understanding of the effect of this diurnal tide it becomes necessary to decompose the observed tide into its diurnal tide or component and the usual semidiurnal tide or component. By referring to Pl. 2, Fig. 1, where this decomposition is shown graphically, it will be seen that near the nodes the diurnal component is zero, and that as the moon's declination increases, passes to a maximum and decreases again to zero, the diurnal component goes through corresponding changes. Its period is seen to be about a day. Moreover this component soon passes in magnitude the semidiurnal component with which it combines to produce the observed tide. As a consequence the observed tide passes from the usual semidiurnal type with two nearly equal maxima and minima a day to a single great tide with one great high and one great low water in a day, the reverse taking place as the moon again approaches her node. It has therefore been convenient to divide the tides into three classes depending on the moon's declination, and which have been called, as above, the great declination tides, the small declination tides, and the intermediate declination tides.

Assuming that each component follows the law of the sines, either one at any particular time can be represented by an equation of the following form:

$$y = A \cos 2\pi \frac{t}{T}$$

in which y = ordinate of curve referred to an axis midway between high and low water, t = time in hours from place of maximum ordinate. T = duration of one tide. A = coefficient. Taking two equations of the above form and combining them we get for the equation of the comple curve,

$$y = A \cos (2\pi \frac{t}{T} - E) + A' \cos 2\pi \frac{t}{T'}$$

in which y = ordinate of obscured curve, T and A = same quantities as above for diurnal curve, t, T', and A' = same quantities as above for semidiurnal component, E = distance between the place of the maximum ordinate of the diurnal component and that of the maximum ordinate of the preceeding semidiurnal component.

While the coefficients A and A' are variable, the one depending mainly on the declination and the other mainly on the phase of the moon, yet for any short time during which they may be regarded as constant it is evident that where A has a relatively large value the character of the resulting curve depends largely on the value of E. Two approximate values for A and A' were found for a particular day, and the calculated and reserved curves given in my report last year, where it was stated

Digitized by Google

that the value of E was about 5 hours. These curves are reproduced on Pl. 2, Fig. 10, and one other, Fig. 11, added, showing the effects of a change in the value of E to zero hours on the resultant tide, the effect of a change in the relative values of A and A′ being shown by Fig. 1. Now, since the height of the observed tide at any time is equal to the algebraic sum of the heights of its components at that time, a glance at the graphical analysis of the observed curve shows that the two components have such a relation to each other (E being so large) that the high water of the diurnal component occurs at a little before low water of the semidiurnal component resulting in its practical obliteration; while low water of the diurnal component occurs a little before, but near the next low water of the semidiurnal component, resulting in a great lowering of the low-water plane. These remarks apply to the period near the moon's maximum declination, either north or south, or, more properly speaking, to when the coefficient A of the diurnal component bears a sensible ratio to A′. Hence it is seen that as A increases relatively to A′, one of the low waters of the semidiurnal tides occurring in a day is obliterated and the other is lowered greatly. From this, then, we have the values of the elevation of the plane of mean high and mean low tide given in Table 4. It is of course understood the S. D. T. give two values each day, the others but one.

Taking up Table 5, the first point which strikes the attention is that the delay in high water for the large tides is much greater than that for the small ones. This may be accounted for in the following manner: It is a well known consequence of theory that of two tidal waves propagated under similar circumstances from the sea into a reservoir that the smaller wave will be reduced in a greater proportion than the larger one. Now, referring to Plate 2, Fig. 1, we see that for the G. D. T. the diurnal component of the observed tide largely exceeds in magnitude the semidiurnal component. But these two bear such a relation that with the value of E existing (about 5 hours) high water of the observed tide precedes high water of the diurnal component by about 4 hours, and follows by about an hour the high water of the first semidiurnal tide. Now, should the latter component be reduced in magnitude in a greater proportion than the former the effect would be to move the time of high water nearer the time of high water of the diurnal component and away from the time of high water of the semidiurnal component. This is exactly what takes place, and there is, therefore, in addition to the delay that would naturally follow the propagation of the tide into a shallow bay, an additional delay caused by the change in the relative magnitudes of the two components. A comparison of Figs. 4, 5, 6, 7, and 8, Pl. 2, giving the two components and the observed tide at the five gauges named above the figures, for the same day, illustrates this clearly.

Again, the Rollover gauge excepted, the delay in high water for the large tides is greater than the delay in low water for the same tides. This is also explained by the relative positions of the two components, for the low water of the diurnal component occurring so near in time to the second low water of the semidiurnal component, any change in their relative magnitudes will have but little effect on the time of low water.

The exception of the Rollover gauge is difficult of explanation, but the following seems to be a probably correct one:

From theory and observation it is found that a tidal wave passing up a shallow estuary gradually changes its form so that its front becomes steeper and its back flatter. As a consequence, the tidal rise occupies a shorter time and the fall a longer time than they occupied at the mouth of the estuary. Now, since the duration of the tide from low water to low water must average the same at the two places in a long series, it results that the delay in high water under such circumstances must be less than the delay in low water. For let us take two triangles of equal bases to represent the duration of the tide from low water to low water and of equal altitudes for convenience, but suppose that a perpendicular let fall from the apex of the one divides the base into two equal parts while in the second it cuts the base at a point to the left of its middle point, Fig. 2, Pl. 2. For this purpose we can suppose the first to represent the tidal rise and fall at the mouth of the estuary and the second that at some distance up. Now place these two triangles on a horizontal time scale graduated from left to right. Since high water at the place up the estuary can not be earlier and generally must be later than high water at the mouth, the second triangle to represent properly the phenomena observed must be placed with its apex to the right of the vertical from the time scale to the apex of the first triangle; hence it is readily seen that the delay in high water must be less than the delay in low water. But if this is true the same state of affairs, other things being equal, should exist at all the other gauges, and in fact this cause does operate to produce such an effect, but at them it is overcome by the causes already given for the opposite state of affairs at those gauges.

The following rule given by Sir G. B. Airy is in point: "If D1, D2, D3, D4 are in arithmetical proportion, then the phase of low water travels with a velocity due to the depth D1, and the phase of high water with the velocity due to the depth D4." It

Digitized by Google

is, of course, understood that the greater depth gives a greater velocity of travel. And I conceive that this effect is shown at the other gauges in the fact that the low-water delay for the larger tides is greater than that for the small tides, for in this case we have a less low-water depth and the rise of tide is a greater fraction of the depth of water. But at Rollover it will be seen that the semidiurnal and diurnal components retain more nearly their relative magnitudes, and as a consequence the effective cause of the greater delay in high water for the larger tides does not exist here. The explanation of this seems to be as follows: The tidal wave having passed through the gorge spreads out into the lower bay and as a consequence is greatly reduced both from the effects of friction and from having passed through a narrow pass into an extended reservoir. Consequently, for all gauges existing in this lower bay the same state of affairs exists, and, as previously stated, the semidiurnal component receives a greater proportionate reduction than the diurnal. Regarding the lower bay as the immediate source of the tides in the upper bay we see at once that the gauges in the upper bay are related to those in the lower bay as these latter were to the one in the Gulf, and similar effects follow the passage of the tide over Red Fish Bar into the broad expanse of the upper bay. But at Rollover the local conditions are entirely different; the tidal wave, after passing over Hannas Reef, passes into a funnel-shaped bay, decreasing in width and depth.

It is a well-known consequence of theory of tidal propagation from a sea into a canal decreasing in width and depth that there are two causes operating to produce opposite effects. These are the friction to reduce and the contraction to increase the tidal fluctuation as it travels up the canal; hence if the latter cause be more potent than the former the tidal fluctuation may increase as the distance from the mouth of the canal increases. Of this there are many examples in nature, of which may be mentioned the estuary of the river Thames, where the tidal range increases from 13 feet at Sheerness to 17 feet at Dufford, is 15 feet at London Bridge, and then gradually decreases, the frictional effect now predominating. From what has been said and by referring to plate 1, it is seen that such an effect, that is, an increase in the tidal range as compared with Hannas Reef, might be expected at Rollover, and in fact such has been found to be the case as shown in Table 5. As a result we may also expect the two components to retain their relative magnitudes, and thus permit the causes producing a greater delay in low water than in high water to have their full effect in the manner shown above. For the same two days near the time of the moon's maximum declination I found that the mean fluctuation of the diurnal component divided by that of the semi-diurnal component gave the following ratios: Bar, 1.57; Gorge, 2.02; Government Wharf, 2.12; Hannas Reef, 2.03; Rollover, 1.60; Red Fish South, 2.42; Red Fish North, 3.60; which are in direct confirmation of what has been advanced. On plate 2, figure 3, is given the theoretical form of a tide wave in a shallow river as deduced by Sir G. B. Airy; it is believed that some resemblance to it can be observed in the Rollover curves. It is to be noted that the right-hand side of this curve becomes the left-hand side of the tide curve as given by a self-recording tide gauge. A further confirmation of the above views is found in the fact that at Rollover the time of rising for the S. D. T. is approximately 5.6 hours, and time of fall approximately 7.0 hours, while at Hannas Reef these quantities are 6.1 and 6.5, respectively.

One of the main objects of the series of tidal-observations now being discussed is the determination of the tidal prism which passes through the gorge, or rather the tidal velocities which occur there and which may be expected to effect scour on the bar by the influence of jetties, but as yet it is the portion of the subject upon which the least of anything precise can be said. That the question for the larger and more effective tides is an extremely complicated one is evident from the unique character of the tides, as well as from other causes which will appear further on. It is therefore to be regretted that it has not been practicable to take a series of observations in the gorge extending over a period of at least a synodical month, to determine the actual velocities of ebb and flow, their directions, durations, and distribution throughout a tide; without this nothing but the roughest approximation can be expected.

The following general considerations are necessary to a clear understanding of what follows:

Assuming that the tide is near low water but still falling, and an ebb current running out, it is evident that the approaching flood must meet and partially overcome this current before any water can enter the bay. It is not believed that this ebb current is reversed completely at the moment of low water, but that, for some time after that event, water is both entering and leaving the bay through the gorge, the two currents, outgoing and incoming, existing at the same time. It is a matter of common observation that the tide will begin to rise some time before the surface ebb current ceases, and divers in their descent have found an outgoing current on the surface and an incoming one near the bottom, and I have read of similar observations being made elsewhere. Now if the moment could be exactly determined when

Digitized by Google

the incoming volume equals in amount the outgoing volume, the readings of the water surface at a number of gauges located throughout the bay, at that instant, would give a lower surface for determining the tidal prism. Proceeding similarly at high water an upper surface could be determined and the prism calculated. But in the absence of any observations to determine these moments of equality, I am forced to make suppositions more or less unsupported in order to render the problem a determinate one.

Before proceeding further it may be well to show that in the calculation of the tidal prism a volume far in excess of the truth would result from using the total fluctuations given in Table 5. For, taking Morgan Point Gauge as an example, we see that it is low water there from 5.2 hours to 6.0 hours after it is low water at the gorge. It is not at all probable that the moment of equality mentioned above is nearly so long as this amount after low water at the gorge, consequently the fall at the former gauge occurring after this moment of equality should be eliminated in the calculation; and similarly at high water it is seen that the water has been falling at the gorge from 5.2 to 7.5 hours before it begins to fall at Morgan Point. It is evident that taking the total fluctuations at both gauges will again err in excess. Since the flow of water depends directly on some function of the slope, some light may be thrown on this question by a consideration of the slopes existing during flood and ebb tide. But to get precise data as to these quantities requires that the zeros of the gauges be connected very closely, and this has, so far, been done only for the Government Wharf, Gorge, and Hannas Reef gauges, and since these results have been availed I have not had time to investigate this question as thoroughly as desirable. In fact, from these three gauges alone sufficient data for a very accurate investigation can not be obtained. With this explanation I will now give some data bearing on the question.

In the following table are given, referred to the hour of high and low water, respectively, for the flood and ebb slopes, the time before these epochs that the maximum slope occurs and the time after them that the corresponding slope ceases, the gauges compared being the Gorge and Hannas Reef:

TABLE 6.—*Hours of maximum and zero slope referred to Gorge hour of high water.*

Tide.	Flood.			Ebb.	
	Maximum slope before high water.	Zero slope after high water.		Maximum slope before low water.	Zero slope after low water.
	Mean.	First mean.	Second mean.	Mean.	Mean.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*
S. D. T	1.5	2.2	.....	2.1	1.0
I. D. T	2.5	5.5	2.4	1.4	2.0
G. D. T	2.1	7.8	3.9	1.4	2.6

From this table it is seen that between the two points, Gorge and Hannas Reef, the ebb-slope has entirely ceased at about 2½ hours after low water at the Gorge. But these gauges are 10 miles apart, and for gauges nearer to the Gorge than Hannas Reef this time would be reduced. Moreover, the Gulf has been rising during this 2½ hours and much faster than the gorge, and as the water is rising rapidly on the bar and falling inside the gorge it is evident that the moment of equality of transfers in and out will soon be reached after the Bar and Gorge gauges are at the same level. This point evidently lies somewhere between 0 and 2½ hours after low water at the gorge. In lack of anything to indicate more definitely its position, I will assume it to be at 1 hour after low water at the gorge for the G. D. T., and for the S. D. T. in the same way it will be assumed at one-half hour after low water.

Again, referring to Table 6, it is seen that the flood slopes between the Gorge and Hannas Reef gauges cease for the S. D. T. 2.2 hours after high-water at the Gorge. But in this 2 hours the Gorge Gauge has fallen a little, and if the water which this fall represents passes into the bay it will be accounted for on some other gauge; if it does not pass into the bay it adds nothing to the tidal prism and therefore should not be counted; hence for these small tides we may take the upper surface of the tidal prism as that existing at about 2 hours after high water in the gorge. Turning to the larger tides Table 6 gives two values for the hour of zero slope, the explanation of which is that the slope may decrease to zero, become ebb in character, again become zero, pass to flood, then to zero, and begin the main ebb. These variations are illustrated in Fig. 9, Pl. 2, where flood slopes are shown above (positive)

Digitized by Google

and the ebb slopes below (negative) the zero line, the tidal curves at the two gauges, Gorge and Hannas Reef, being also given. It is evidently difficult under such circumstances to draw any general rule. But as it is evident that but little water will escape during the short duration and small slopes of the small intermediate ebb and but little water added during the small intermediate flood (they will probably about counterbalance each other), we may say that the upper surface of the tidal prism will be given at the time of the first flood zero, or say 4 hours after high water at the Gorge. For the same reason as before the fall during this time at any of the gauges should not be counted; moreover, as during this period there is no counter slope to produce an ebb current, the whole tendency will be to force water into the bay.

Based on the above reasoning I have determined a mean tidal prism for the S. D.T. and for the G. D. T.; the I. D. T. I have omitted, as the above remarks for either class of tide do not apply to them so closely; they are therefore reserved for a future date, together with a further study of those presented now.

For the G. T. D. I find that the tidal prism is 10,729,960,000 cubic feet, and for the small tides 3,187,875,000 cubic feet, made up of the partial prisms as given in the following table:

TABLE 7.—*Tidal prisms of Galveston Bay.*

Basin.	Area.	G. D. T.	S. D. T.
	Square miles.	*Cubic feet.*	*Cubic feet.*
Upper Bay	233.8	2,542,000,000	130,360,000
East Bay	72.8	2,486,200,000	882,850,000
West Bay	30.6	682,460,000	170,615,000
Lower Bay	131.9	5,019,300,000	2,004,050,000
Total	469.1	10,729,960,000	3,187,875,000
Bar area	8.0	107,610,000	50,739,000

The quantities given for the G. D. T. pass through the gorge twice every day and those for the S. D. T. four times a day whenever the particular class of tide exists to which they belong. From the series of slopes from which Table 6 was deduced I found that on an average the flood slope from its commencement to its first zero lasted about 10 hours and that the ebb from the last flood zero to its end lasted about 9.4 hours during G. D. T. For the S. D. T. the ebb and flood slopes are of about equal duration of about 6 hours each. Taking the cross section of the gorge as about 160,000 square feet, it is easily calculated that the water must flow through the gorge with an average velocity for the different cases as follows:

For G. D. T. during flood.....feet per second..1.87
For G. D. T. during ebb.....do....1.98
For S. D. T. during flood and ebb.....do....0.92

It is here assumed that the duration of flow and slope in the same direction are equal. This, from lack of observations to determine the relation between these quantities, is the only one that can be made, and is no doubt very near the truth. I have left out of consideration the time when the slopes vary about the zero, as was done in the calculation of the tidal prism.

But in the case of tidal flow we know that the current in either direction begins at zero, increases to a maximum, and then decreases to zero, and I know of no formula which will apply to such a case; that is, to where the slope, the cross section, and probably the coefficient of friction vary with the time. Such a formula, could it be devised, would be extremely complicated, and require an immense number of observations for its determination. Nor is it believed that tidal velocities bear the same relation to the slope that holds in rivers and canals, where the slope remains constant for a considerable length of time. Moreover, in the G. D. T., the existence of the large diurnal component, occurring at the time it does in relation to the semidiurnal component, tends to produce a complexity of currents, making it unsafe to predict anything as to the actual velocities from the slopes existing at any particular time. In a report of a board of engineers dated January 21, 1886, in which this harbor is considered, it is stated that "where the tidal heights give with time as abscissas a tidal curve of regular and nearly sinusoidal form, as is the case at the Narrows in New York harbor, the velocity curve during a tide with times as abscissas has a similar form, which may be represented approximately by a triangle; whence it follows that the maximum mean velocity during a tide is about double the mean velocity for the whole period of the rise or fall."

Digitized by Google

Digitized by Google

Photo-Lith. by A. HAEN & CO., Baltic., Md.

Digitized by Google

Digitized by Google

HIRD APPROXIMATION,

FIG. 4

BAR

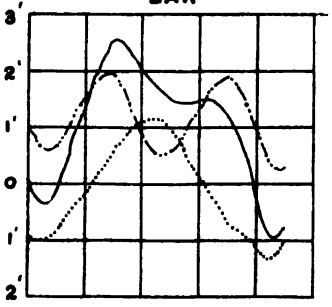
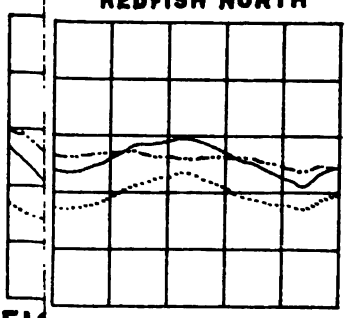


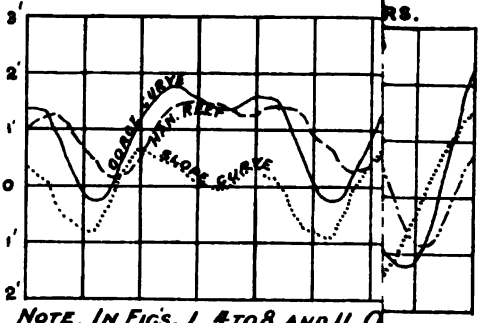
FIG. 8

REDFISH NORTH



FIG

RS.



NOTE. IN FIGS. 1, 4 TO 8, AND 11 O

XAS. JUNE 30. 1891

THIS DATE

THE DIURNAL COMPONENT IS PLA

LIEUT. CORPS OF ENGRS. U.S.A.

Photo-Lith. by A. HOEN & CO.

Digitized by Google

It will be seen by reference to fig. 9, plate 2, that this representation can be made at the gorge for the ebb in both the tidal and slope curves, and also approximately for the flood-slope curve, but less so for the flood-tidal curve. Assuming this law as true, the maximum mean velocities become 3.74, 3.96, and 1.84 feet per second. A good series of velocity observations taken in the gorge would test these results. What velocity observations have been taken in the past are too few in number, have not been located in the gorge, and have been taken for other purposes. They consequently throw no light on the present discussion. It will be noted that these velocities are in excess of those given by the Board of Engineers in the report quoted above; this arises mainly from the fact that I have assumed a shorter period of ebb and flow than there assumed.

The ebb velocities above given for the G. D. T. are stronger than those given for the flood. This arises from the fact that the time of filling the bay was assumed longer than the time of emptying. That this supposition is probably correct is shown by the following data compiled from a comparison between the Gorge and Hannas Reef gauges through seventeen G. D. T.:

	Feet.
Average flood slope between these gauges	0.353
Average ebb slope between these gauges	0.430
Average maximum flood slope between these gauges	0.630
Average maximum ebb slope between these gauges	0.910

From which it is seen that the average and maximum ebb slopes are greater than the corresponding flood slopes, and hence greater velocities may be expected from them. There is another factor which may at times increase the ebb velocities over the flood, and that is the fresh water which the bay receives from the bayous and rivers emptying into it. In times of flood this undoubtedly amounts to a considerable volume, but it has never been evaluated. An indication of its amount is given by the fact that when the San Jacinto and Trinity rivers are both very high the Upper Bay becomes fresh almost throughout its whole extent.

As shown in Table 6 the maximum flood slopes occur for the G. D. T. 2.1 hours before high water, and the maximum ebb slopes 1.4 hours before low water, and as a consequence the maximum velocities should be expected somewhere near these same times and probably after them. From the same table it is seen that that the main ebb does not begin for the same class of tides until about 8 hours after high water, and that it ceases about 2.5 hours after low water. In table 3 of my report dated July 1, 1889, it is shown that on the bar the rise to high water occurs in about 8 hours. An inspection of the G. D. T. will show that for the purposes of this discussion the rise may be taken as proportional to the time; consequently, when the ebb slope has ceased or become very small it may be said that the tide has risen say one-third of its way to high water, or about 0.91 feet. Hence considering the slopes occurring after the maximum, it may be said that the ebb current has practically ceased when the tide has risen from low water to 0.91 feet above the plane of mean low tide for the G. D. T., or 0.26 feet above the plane of reference. In the same table (3) of July 1, 1889, it was shown that the tide on the bar fell 0.5 of a foot in 4 hours, and to low water in 16.9 hours; hence in this case it can not be assumed that it will fall a foot in 8 hours, because it fell one-half foot in 4 hours. But it will fall more than one-half and less than 1 foot. In lack of more exact data let us take 0.75 of a foot as the probable fall in 8 hours. Then it is seen that the ebb current for the G. D. T. practically does not begin until the water has fallen from high water 0.75 of a foot below the plane of mean high tide, or to a point 1.33 feet above the plane of reference. As the ebb current commences at zero and gradually increases it would seem that the strong velocities will not be reached until the water has fallen considerably below this latter limit (+1.33 feet), but may occur before it has fallen to the former one (+0.26 feet).

The flood velocities, of course, practically begin when the water has risen to the first limit (+ 0.26 feet), and end when it has fallen to the second (+ 1.33 feet).

In the I. D. T. the above limits will apply equally well to at least that half of them which is nearest the G. D. T.; therefore, the above limits will apply to the tides occurring on more than one-half of the days in a synodical period. As these tides furnish the controlling or greatest velocities the others have not been considered.

The above figures are to be considered approximate; exact ones could only be obtained by comparisons made after the bar and gorge gauges had been connected by a line of precise levels.

In Table 7 it will be seen that for the S. D. T. the Upper Bay adds only 130 million cubic feet, corresponding to a tidal rise of only 0.02 of a foot. For the G. D. T. 0.39 of a foot was found to represent the effective tidal fluctuation. These figures show what a reduction in the effective tidal prism the delays in high and low water cause.

Digitized by Google

In the table of tidal prisms, the horizontal line under the totals gives the area and prism to be added when the jetties are both carried out to the bar, other things supposed to remain equal.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut., Corps of Engineers.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

REPORT OF MR. E. M. HARTRICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1891.

SIR: I have the honor to submit the following report of operations for improving Galveston Harbor, Texas, during the fiscal year ending June 30, 1891.

Mr. H. C. Ripley, assistant engineer, had immediate supervision of the work to August 13, 1890, when First Lieut. W. C. Langfitt, Corps of Engineers, took supervision, followed by Mr. E. M. Hartrick, assistant engineer, from October 1, 1890, to the end of the fiscal year.

CONDITION OF CONTRACT.

At the end of the last fiscal year the contract with Messrs. A. M. Shannon & Co., was still unfinished, although they had had two extensions. The present fiscal year was entered on with a third extension to August 30, 1890, on which date they finally completed their contract, the expense of inspection and measurement of material being deducted as before.

SUPPLEMENTARY REPORT TO LAST FISCAL YEAR.

In Lieut. W. C. Langfitt's report of October 15, 1890, supplementary to the report for the last fiscal year, he states that, from longitudinal profiles and cross sections taken after the work was finally completed by the contractors, compared with those of the year before, he deduces the following:

"From Station 0 to Station 9 + 60 the crest has been raised. This is due to riprap placed during the year to fill voids which existed among the blocks. From Station 9 + 60 to Station 96 the work was left unfinished in the center to allow as much settlement as possible to take place before completing the crest. This distance was completed during the year and the effect has been to raise the crest except in a few places which had been completed at the end of the fiscal year 1888–'89. Notwithstanding these additions, from Station 59 to Station 70 the average settlement has been 0.829 feet and maximum 2 feet, and from Station 70 to Station 74, the average settlement has been 0.285 feet, with a maximum settlement of 1 foot. This settlement was due probably to the high tides of April, May, and June this year (1890): which caused a general settlement of the shore branch, but which was covered up by additions made after its occurrence. From Station 96 to Station 134, or over that portion of the jetty where the clay core exists, there was more or less settlement going on throughout the year, but as stone was added continually, this portion of the jetty has been raised in height. * * * A continuation of this settlement may be expected throughout this portion of the jetty. From Station 134 to Station 150, the end of the completed work June 30, 1889, there has been practically no addition of stone during the year.

"I have divided this distance into three portions, as follows:

"1. From Station 134 to Station 138 there has been practically no change.

"2. From Station 138 to Station 144 the average settlement has been 0'.46 with a maximum of 1.2 feet.

"3. From Station 144 to Station 150 the average settlement has been 0'.45 with a maximum of 1 foot. * * *

"It is evident that the consolidation and settlement goes on slowly and that several years will be required from the completion of such a jetty until such movements cease.

"The remainder of the completed work having been finished since June 30, 1889, no comparison has been attempted.

"It will be noticed that a scour is shown in advance of the completed work from Station 195 + 50 to Station 198 + 68. This scour averages 1'.56, with a maximum of 3 feet. * * * The scour is evidently the result of the current whipping around the

Digitized by Google

end of the work, and as it may take place as fast as the work is pushed out, it practically adds so much in height to the jetty to be constructed. From data in hand, the distance which this scour extends out can not be determined, but the facts so far as they go would indicate the advantage of at once carrying out a layer of riprap over the old mattress jetty should the scour extend further than the length of the jetty under construction at any one time. * * *

"In regard to changes in the bottom in the vicinity of the jetty, it may be said that from Station 0 to Station 79 there practically has been no change; that from Station 80 to Station 153 a fill on both sides of the jetty is shown, and the bottom is generally raised above what it was originally. As the work advances a deep trench is scoured along the jetty near the end and is filled up as the work progresses, the final result being to eliminate the shallower trench which generally existed on both sides of the old mattress jetty."

INCIDENTAL SURVEYS AND OBSERVATIONS.

In August and September, 1890, a survey of part of the outer bar and its channels was made to determine any changes that might have occurred after completion of the contract. On plotting the survey and comparing the curves of depth with those of the survey made in April, May, and June, 1890, no appreciable change could be observed.

About six months after the completion of the work a profile over the axis of the jetty was taken in the latter part of January, 1891, together with cross sections every 1,000 feet in the first part of February, 1891. By comparing these sections with those taken at the end of last fiscal year and completion of contract it was found that there had been no decidedly marked change, with the exception of a slight settlement between Stations 22 and 24, and a general settlement over that part of the jetty completed toward the end of last contract.

In April, during and after the running of a construction train for the repairs of the Life-Saving Station, a slight settlement was observed between Stations 9 and 60.

There has been no profile nor cross sections taken over the completed jetty for this report, as the change would be so slight that a comparison could not be made of any practical value.

ADVANCE OF THE WORK DURING THE YEAR ON SOUTH JETTY.

End of completed work June 3, 1890, Station 180; end of completed work June 30, 1891, Station 194; advance this year, 1,400 feet. End of incomplete work June 30, 1890, Station 192; end of incomplete work June 30, 1891, Station 195+50; in advance of completed work, 150 feet. End of trestle June 30, 1890, Station 196+28; end of trestle June 30, 1891, Station 198+68; constructed this year, 240 feet.

TABLE No. 1.—*Showing kind and amount of stone used.*

Month.	Cars.	Riprap.	Cars.	Blocks.	Total cars.
July	426	5,991.99	321	2,025.65	747
August	337	4,977.54	363	2,294.35	700
Total	763	10,969.53	684	4,320.00	1,447

TABLE No. 2.—*Showing quantities of stone used and cost of same in the work and other items of expense, not including office and inspection expenses.*

0 to 79+64 (7,964 feet).

Items.	Cubic yards.	Cost.	Cubic yards per foot.	Cost.
				Per foot.
Riprap	4,179.88	$8,694.15	0.52	$1.09
Blocks				
Railway				
Extras		13.86		
Total for year	4,179.88	8,708.01	0.52	1.09
Previous expenditures	40,080.24	135,681.08	5.03	17.04
Grand total	44,260.12	144,389.09	5.55	18.13

Digitized by Google

TABLE NO. 2.—*Showing quantities of stone used and cost of same in the work and other items of expense, etc.*—Continued.

79 + 64 to 84 + 64 (500 feet).

Items.	Cubic yards.	Cost.	Cubic yards per foot.	Cost.
				Per foot.
Riprap				
Blocks				
Railway				
Extras		$1.48		
Total for year		1.48		
Previous expenditures	5,998.81	16,186.84	12.00	$32.37
Grand total	5,998.81	16,188.32	12.00	32.37

84 + 64 to 95 + 64 (1,100 feet).

Riprap				
Blocks				
Railway				
Extras		3.14		
Total for year		3.14		
Previous expenditures	9,594.51	28,921.05	8.72	26.30
Grand total	9,594.51	28,924.19	8.72	26.30

95 + 64 to 107 + 64 (1,200 feet).

Riprap				
Blocks	377.99	1,625.36	.32	1.35
Railway				
Extras		3.99		
Total for year	377.99	1,629.35	.32	1.35
Previous expenditures	12,716.48	39,497.12	10.60	32.92
Grand total	13,094.47	41,126.47	10.92	34.27

107 + 64 to 138 + 64 (3,100 feet).

Riprap				
Blocks				
Railway		14.12		
Extras		8.80		
Total for year		22.92		.01
Previous expenditures	72,180.09	215,955.62	23.28	69.66
Grand total	72,180.09	215,978.54	23.28	69.67

138 + 64 to 144 + 12 (548 feet).

Riprap				
Blocks				
Railway				
Extras		1.60		
Total for year		1.60		
Previous expenditures	12,567.62	39,067.88	22.93	71.29
Grand total	12,567.62	39,069.48	22.93	71.29

Digitized by Google

TABLE NO. 2.—*Showing quantities of stone used and cost of same in the work and other items of expense, etc.*—Continued.

144+12 to 150 (588 feet).

Items.	Cubic yards.	Cost.	Cubic yards. per foot.	Cost.
				Per foot.
Riprap				
Blocks				
Railway				
Extras		$1.72		
Total for year		1.72		
Previous expenditures	12,740.68	34,278.65	21.67	$58.30
Grand total	12,740.68	34,280.37	21.67	58.30

150 to 160 (1,000 feet).

Riprap				
Blocks				
Railway				
Extras		2.84		
Total for year		2.84		
Previous expenditures	19,623.31	54,535.75	19.62	54.54
Grand total	19,623.31	54,538.59	19.62	54.54

160 to 170 (1,000 feet).

Riprap				
Blocks				
Railway				
Extras		5.30		
Total for year		5.30		
Previous expenditures	19,679.77	53,703.89	19.68	53.70
Grand total	19,679.77	53,709.19	19.68	53.70

170 to 180 (1,000 feet).

Riprap	123.31	256.48	.12	.27
Blocks				
Railway				
Extras		16.51		
Total for year	123.31	272.99	.12	.27
Previous expenditures	13,162.67	38,289.53	13.16	38.29
Grand total	13,285.98	38,562.52	13.28	38.56

180 to 190 (1,000 feet).

Riprap	1,568.43	3,262.33	1.57	3.26
Blocks	2,467.52	10,610.33	2.47	10.61
Railway				
Extras		6.06		.01
Total for year	4,035.95	13,878.72	4.04	13.88
Previous expenditures	10,454.92	26,982.08	10.45	26.98
Grand total	14,490.87	40,860.80	14.49	40.86

Digitized by Google

TABLE No. 2.—*Showing quantities of stone used and cost of same in the work and other items of expense, etc.*—Continued.

190 to 198 + 68 (868 feet), incomplete from 194.

Items.	Cubic yards.	Cost.
Riprap	5,097.91	$10,603.65
Blocks	1,474.49	6,340.30
Railway	.....	942.01
Extras	.....	2.21
Total for year	6,572.40	17,888.17
Previous expenditures from Station 190 to Station 196 + 28	1,959.13	6,417.56
Grand total	8,531.53	24,305.73

See Table No. 3 as to cubic yards per foot and cost per foot between Stations 190 and 194 and Stations 194 and 198 + 68.

TABLE No. 3.—*Synopsis, showing average cost per foot between the following stations.*

[Cost per foot includes railway and extras.]

Stations.	Distance.	This year.		To date.		Remarks.
		Cubic yards.	Cost.	Cubic yards.	Cost.	
	Feet.	*Per foot.*	*Per foot.*	*Per foot.*	*Per foot.*	
From 0 to 79+64	7,964	0.52	$1.09	5.55	$18.13	Shore connection.
79+64 to 84+64	500	.....	.....	12.00	32.37	Across old channel.
84+64 to 95+64	1,100	.....	.....	8.72	26.30	
95+64 to 107+64	1,200	.32	1.53	10.92	34.27	Clay core.
107+64 to 138+64	3,100	.....	.01	23.28	69.67	Do.
138+64 to 144+12	548	.....	.....	22.93	71.29	Do.
144+12 to 150	588	.....	.....	21.67	58.30	.....
150 to 160	1,000	.....	.....	19.62	54.54	.....
160 to 170	1,000	.....	.....	19.68	53.70	.....
170 to 180	1,000	.12	.27	13.28	38.56	.....
180 to 190	1,000	4.04	13.88	14.49	40.86	.....
190 to 194	400	14.32	37.09	19.22	51.69	.....
194 to 198+68	468	1.80	7.76	1.80	7.76	Unfinished.

On old mattress work.

Over that part of the jetty having the clay core there was expended during the year $1,625 to keep it up to the required height.

CONSTRUCTION.

The general method of construction was the same as last year. The trestle and railway tract were kept in advance; riprap was then dumped on the old mattress work and brought up to the surface of the water; blocks were then deposited on the sides to a height slightly above the riprap; then additional riprap between the blocks; then more blocks covering the riprap to the proper height.

STONE.

From 90 to 95 per cent. of the stone used from quarry station on the line of the Gulf, Colorado and Santa Fé Railway was loaded on flat cars by more or less mechanical means, and was brought down by rail and disposed of in the jetty by manual labor, with a pitch-bar to assist in dumping the larger blocks. A steam derrick followed to finish up by placing in a more compact manner the large blocks between low water and top of jetty, the blocks having been previously dumped as near as possible to the place required.

CASUALTIES.

There has been no damage to the completed work, except the usual settlement to a stone jetty and the deterioration of a trestle and track exposed to the elements in such a location.

In the latter part of April, 1891, the trestle, which had been extended in advance of completed work, began to show signs of failing by reason of a few of the bearing

Digitized by Google

piles having been carried away, most likely by drift logs and large waves pounding an exposed structure supported on piles honeycombed by the *Teredo navalis*. At the time of storm and boisterous weather had passed and a new contract had nearly been consummated it was deemed best to delay repairs until such time as contractors should have men, material, and appliances on hand for such work.

The contractors are now making preparations for the removal of rails and securing the timber framing.

MISCELLANEOUS ITEMS.

The jetty office at Fort Point, on Government reserve, was repaired and enlarged in anticipation of a vigorous prosecution of the harbor improvement. A survey of Bolivar Point was begun and finished, showing the topography of that part of the peninsula where the proposed shore connection will start for the extension gulfward of north jetty.

During the months of April and May, 1891, the superintendent for the repairs of the life-saving station at Fort Point was allowed the use of the jetty railway track for his construction train loaded with stone, clay, and sand.

ANNUAL SURVEY.

The annual survey was commenced in May and finished in June, 1891. A portion of the field notes have been plotted to compare with last annual report and its accompanying chart. The changes noted are as follows:

The channel through the outer bar has about the same depth as last year, 13½ feet; the distance between the 13-foot curves is more uniform and has a slightly greater width.

In this connection I wish to state that all comparisons are from the plane of reference used last year.

The average rise and fall of the tide on the bar has also been determined, showing that at ordinary high water there are 15 feet and over.

In the gulf the 30, 24, 18, and 12 foot contours have advanced. In Bolivar Channel the 18 and 24 foot contours have receded, the 12 and 30 foot contours remaining stationary.

Bird Island Shoal, off Bolivar, has advanced slightly towards the south with a corresponding movement of the 12, 18, 24, and 30 foot contours. There has also appeared at the western extremity of the above shoal a small area which is uncovered at low water.

The 18-foot contour south of the outer end of the old mattress jetty has disappeared, and the 8-foot shoal on the north side of jetty is detached and has a less area.

At the extreme end of the completed work there is a 12-foot contour with a maximum depth of 16 feet; it extends for a maximum width of 800 feet on the north to 200 feet on the south of mattress jetty and in length about 2,000 feet in advance of the completed work.

The 6-foot contour abreast of and north of completed work has advanced slightly; the 6 and 8-foot contours on the south remain about the same with a decided advance of the 3-foot contour. The general tendency along both sides of the completed jetty is a shoaling and a filling up of the trench which forms on both sides of the jetty as it advances.

Of the small accretion, part of the original Government reserve, but recently reappearing immediately south of and between stations 140 and 150, a larger area is above water, and its probable attachment to Galveston Island and the jetty may be looked for in the near future. This tendency of the beach gulfward will continue as the stone jetty advances, showing conclusively that the east end of the island, for at least a considerable distance, will be protected against erosion.

The inner bar at the entrance to Galveston Channel has a better approach than formerly, the curves being more regular, and the shoal off Fort Point Light-House gradually receding. The bar has about the same depth of water as last year, a good 21 feet.

Very respectfully, your obedient servant,

E. M. HARTRICK,
Assistant Engineer.

Maj. CHARLES J. ALLEN,
Corps of Engineers, U. S. A.

Digitized by Google

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

GALVESTON, TEX., *June 30, 1891.*

SIR: I have the honor to make the following report on precise leveling operations which were carried on from March 10, 1890, to July 10, 1890, in accordance with your instructions.

The object of these levels was to connect the zero of the tide gauges on Galveston Bar and in Galveston Bay with the B. M. on the Hendly Building, which is 2,096.7 millimetres above the established plane of reference. On March 20 one leveling party was organized and went into camp on Bolivar Point. The party consisted of Mr. A. L. Johnson, observer, Mr. T. P. Griffith, recorder, Mr. G. W. Allen, and Mr. Houston Jones, rodmen, with three attendants and axmen. After the instrumental constants had been determined a line was commenced from P. B. M. No. 1, on Bolivar Light House, and run up the peninsula as far as Elm Grove, opposite Hannas Reef Gauge. The chief difficulty which presented itself to the execution of this work was how to carry the levels across the numerous long stretches of water between shore and the gauges, a difficulty which became more apparent as the work of building platforms on an unstable foundation in strong currents progressed.

It had been intended to run a line around Galveston Bay, commencing at Bolivar Point and running as close as practicable to the shore into Galveston across the railroad trestle, with which line the gauges were afterwards to be connected. This plan, however, as the work progressed, owing to the difficulty of leveling over marsh land and of getting around the flooded country adjacent to the Trinity, San Jacinto, and other streams, was abandoned in favor of one which contemplated the starting of two separate lines; one to cross the Gorge and connect with the "Gorge," "Bar," "Hannas Reef," and "Rollover" gauges, the other to cross West Bay on the railroad trestle and connect with "Redfish N.," "Redfish S.," and "Morgan Point" gauges. Before, however, this could be definitely decided upon it was necessary to ascertain the practicability of crossing the gorge in order to connect the bench-mark on Hendly Building with P. B. M. No. 1 of the line then being run from Bolivar Light-House, and it was determined, as an experiment, to connect that line with the gauge at Hannas Reef as soon as the leveling party should reach there.

On April 12 the line from P. B. M. No. 1 to Elm Grove was completed and P. B. M. No. 5 established there. This distance is 12.61 kilometres, but the actual length of line leveled was 29.95 kilometres, as many of the stretches had to be releveled several times on account of the marshy character of the ground over portion of the route. On April 13 the schooner *Andrew Boden* was chartered for this work, and having taken the necessary materials and appliances for platform construction on board sailed for Elm Grove with the leveling party.

RECIPROCAL LEVELING ON PLATFORMS.

As but little information on reciprocal leveling at long distances was at hand either as to the limit at which good results could be obtained or on the best method of constructing platforms, it was decided to experiment at the crossings at Hannas Reef, the conditions being favorable at that point for such tests. Four platforms, A, B, C, D, were accordingly constructed on shore and two platforms, E and F, in the water. Platforms E and F consisted of three piles, well braced, for the instrument to stand on, with a sheet-pile protection around it to prevent vibration from the surging of the waves or from the wind; the piles of this protection also supported a floor for the observer, recorder, umbrella man, and flagman. These platforms were about 5½ feet above mean low tide so as to bring the level to a height of 10 feet, this being considered the plane of least variable refraction; they were constructed on the general plan shown in sketch (Plate 2), but were of much lighter construction and not provided with a rock apron around them, the locality being sheltered and the water shoal. The rods were provided with targets 1 foot square, painted red, and having a white streak 1½ inches wide, painted horizontally across the center; these targets were set by flag signals as nearly as possible, so that the middle wire of the instrument should bisect the white streak, and the reading of the rod then noted by the rodman, a fine wire stretched across a hole in the target enabling him to read with accuracy. When the levels had been completed across the various spans they were checked by levels across two spans at a time and then connected with a bench-mark on the southwest pile of Hannas Reef Tide House (see Table No. 2).

On the completion of the work at Hannas Reef the party sailed for Galveston and commenced making preparations for crossing the gorge, the results at Elm Grove having demonstrated the fact that good results could be obtained on platforms 1,378 metres apart, which was the greatest distance experimented at, and the facility with which the readings were obtained at this distance, combined with the closeness of the results, were considered evidence that by increasing the number of observations much longer shots could be taken with equally good results.

Digitized by Google

CROSSING THE GORGE AT GALVESTON.

A line of shore levels having been run from P. B. M. No. 6, on the Hendly Building, to Platform Q, near the quarentine station, on May 6 the schooner *Mathilda* was chartered and having been fitted out with a pile-driver and taken the necessary material on board sailed for the gorge and commenced work on the platforms. This work occupied till June 12.

The gorge has a width of 2,851 metres from shore to shore. For about 1,884 metres of this distance it has a depth exceeding 10 feet, which was considered to be the greatest depth at which it was practicable to construct, at reasonable cost, platforms which would be rigid enough, as in deeper water it would have been necessary to have changed the plan of construction to a much more costly one. It was therefore necessary to level across this width of 1,884 metres, which was 506 metres greater than the longest shot at Hannas Reef, and for this reason it was considered advisable to cross the gorge with two independent lines.

The strong currents and unstable bottom which scoured very rapidly as soon as the obstruction offered by the sheet piling was presented to the former made the difficulty of building these platforms very much greater than was anticipated. One platform, constructed on Bird Island Shoal in about 4 feet of water, and having the piling 17 feet in the sand, was carried away bodily, the bottom having scoured out around it, and it was found necessary to put an apron of rock around the others as soon as built, an addition which increased materially the cost. Almost continuous strong winds also added much to the difficulty of doing this work, and at times caused serious injury to platforms in process of construction.

Platform P, off Pelican Spit, was commenced on May 10 and finished on May 16. This platform was constructed in 6 feet of water (see Plate 2).

Platform BI. was then commenced on Bird Island Shoal and finished on May 21. This platform was caried away on June 2.

Platform GG, 110 metres north of the gorge tide house, was commenced on May 22, and was nearly completely on May 23 when work on it had to be suspended on account of bad weather. On May 26 it was so badly injured during a gale that it was found necessary to construct a new one; this latter owing to bad weather was not finished until June 12.

While the construction of platforms was progressing the leveling parties availed themselves of every opportunity to get observations. Each party consisted of an observer, a rodman, a recorder, a flagman, an umbrellaman, and one or more oarsmen, Mr. Gerald Bagnall, with level No. 1, observing at one platform, and Mr. A. L. Johnson, with level No. 5, at the other.

It had been intended to cross the gorge by two lines, one from Q going by P and BI platforms to B_1, the other by Fort Point (on jetty) and GG platform to B_2, and thence on shore to B_1, forming a polygon, but the destruction of platform BI made it necessary to go from P to GG, thus connecting with the other line at that point, making two polygons instead of one, and introducing a span of 1,945 metres. A number of observations taken between Q and P from May 16 to June 10 were not considered satisfactory, for although the mean result was nearly the same as found later, yet the discrepancies between the different sets was so great as to cause their rejection; this was due to working in windy weather. A number of observations taken between BI and P, and between BI and B, before the destruction of the former, are also of no use, not having been completed. The number of sets of observations taken depended on the closeness of the results obtained, but was never less than three.

The results of these levels was closer than had been expected, the probable error between Q and GG having been only 0.4 millimetre, and between GG and B_1 1.6 millimetres. The method of taking observations here was the same as at Hannas Reef, but the length of time required to get a satisfactory observation increased very much with an increase in the distance.

PLATFORM ON THE BAR.

On June 19 work was commenced on Platform No. 1 on Galveston Bar, about 1 mile from shore, and continued until June 30, when, it being finished, work was suspended and the schooner *Mathilda* paid off, as the funds allotted were nearly expended. This platform differs from sketch plate 2 by having 2 piles at each of the corners of the sheeting, and on the exposed sides at a distance of 40 feet from the platform a wave-breaker composed of clumps of piles driven 20 feet apart with two horizontal stringers bolted across. On the completion of work the instrumental constants were again determined.

METHODS OF WORK.

On the shore work two lines were run in opposite directions by the same observer, and if the result did not come within the required limit of discrepancy (2 milli-

Digitized by Google

meters $\sqrt{2k}$) a third and sometimes a fourth line was run. This small limit was adopted on account of the great accuracy required in the results. The bubble was always kept in the center on both the land and the platform work, and I can not too strongly indorse the recommendation of this method made by Mr. J. B. Johnson in his report (see Report of Chief of Engineers, 1884), as it not only saves a vast amount of office work, but I am convinced that the elimination of error arrived at by working always with a bubble of as nearly as possible the same length in the center will give more accurate results than the most carefully made corrections, especially when the latter are complicated by some instrumental defect, as was found in the case of Bubble Tube No. 1, which was used with Level No. 5. Foot plates were first tried for the rods on the shore work, but they were abandoned in favor of iron pins 1½ feet long. Iron pins were also used over portions of the route for the legs of the instrument to rest on. In the long shot reciprocal levelling it was found necessary to mark the position of the bubble on the rings of Level No. 1 by lines scratched on the latter, as owing to the great wear on the object-end ring, presumably caused by the constant determining of the inclination of the bubble on shore work, any little change in the position of the bubble longitudinally with the optical axis of the telescope caused a change in the reading. This was also done with Level No. 5, which instrument, however, being much newer, does not show the same wear where the bubble legs rest. The value of p for telescope erect in Table No. 1 shows the extent of this wear in the case of Level No. 1.

In the reciprocal leveling the observations were taken in sets of four shots each in the following order: Telescope normal, level direct; telescope normal, level reversed; telescope inverted, level reversed; telescope inverted, level direct; thus eliminating the errors due to inclination and collimation, and as the mean of the differences of elevation found by both instruments give a result with $c-r$ eliminated, the only error remaining was that due to the inequality of the pivot rings of the two instruments. To eliminate this, after a sufficient number of sets of observations had been taken, the observers changed platforms, taking their instruments with them, and read a number of sets of observations from their new stations. The mean of the differences of elevation found by all these sets gives the true difference of elevation. The readings were taken as nearly as possible simultaneously on account of the changes in refraction, which were very noticeable at the long distances, a few minutes' delay often necessitating a resetting of the target. During these observations on the platforms in the water the bubble was, as a rule, in a constant state of motion, owing to the vibration of the platform. As this movement was very slight and uniform the bubble moved within well-defined limits, and the observer was able, with care and patience, to set the target accurately. While this motion of the bubble interfered seriously with the rapidity of working, it had the beneficial effect of preventing the liquid from being held from a true level by adhesion. Most of the work was done between 6 and 9.30 a. m. and between 3 and 7 p. m. Two temporary bench marks were usually set at the end of each day's work on the shore work, and it having been found that a slight change in their comparative elevations sometimes occurred in soft ground or after rain, the mean of the two would be taken. This is indicated in the notes by having the letter m placed after the number of the bench mark.

BENCH MARKS.

Seven permanent bench marks were set and two more established on the anchor bolts of Fort Point and Bolivar Light-houses; those which are not located by permanent land marks close by were located by sextant angles. A list of bench marks with their locations is given on table No. 5.

INSTRUMENTS.

The instruments used were Kern levels No. 1 and 5, with bubble tubes Nos. 3 and 1, respectively. Rods Nos. 11 and 13 were used throughout. Iron pins were used for both the rods and tripod legs. The former had a wooden plug set in the head in order to afford good holding ground for the points of the tripod legs. Tents were used when necessary on the shore work, but wind umbrellas were found to be more convenient when not too windy. The latter were used altogether on the platforms. The rods were provided with targets as already described for the long-shot work.

INSTRUMENTAL DEFECTS.

In the first determinations for the value of one division of bubble tube No. 1 it was noticed that the change in the rod readings with the bubble at the object end was greater than with the bubble at the eye end, and Mr. Johnson, in his second determination on July 1, read his bubble first in the center, then about five divisions

Digitized by Google

toward the eye end, and then the same number of divisions toward the object end, making in all 30 observations for each station 10 metres apart, beginning at 10 metres from the instrument and ending at 100 meters. Without a single exception he found the difference of rod reading with the bubble run to the object end greater than when run to the eye end, and varying in amount from 25 to 100 per cent.

In tables 3 and 4 the algebraic sum of the values of the *p's* of levels No. 1 and 5 can be found by subtracting the difference of elevation found with the levels in either position from the final difference of elevation, and it will be noticed that the values are constantly changing, which is in accord with past experience with that constant. The values found as above are, of course, not absolutely correct, as, besides errors of pointing, there are also probably slight errors due to the effect of temperature on the instruments and to irregular refraction. (See refraction.)

REFRACTION.

Corrections for the constants and for the earth's curvature were applied to 46 sets of reciprocal observations in order to ascertain the refraction at different hours of the day and under various conditions of temperature and of barometic pressure.

Table No. 6 gives the mean of the refraction of a number of observations during each hour from 7 a. m. to 12 noon, and from 3 p. m. to 7 p. m. it shows a very decided and gradual decrease of refraction to 11 a. m., and a slight decrease between 11 and 12; between 3 and 5 it is practically constant, then a gradual increase to 7 p. m. The absence of a complete temperature and barometric record on the ground, together with the presence of errors of pointing and of changes in the values of the *"p's"* of both instruments between the time that constant was determined and the time the observations were taken prevent anything but this general averaging of results. It was noticed as the work progressed that the rod readings of both observers changed in opposite directions. Investigation shows that as the sun's rays came more in the direction of any one line of sight, and, at the same time, in opposition to the other, that the rod readings in the first case became greater, while in the last they became less. There were a few exceptions to this, but there is a great preponderance of evidence to show that there was either an irregular refraction, or that the instruments were effected differently by changes of temperature. Errors due to this can not be measured, but it is possible to a great extent to eliminate them by taking observations across the same span under different conditions of light. Before concluding I wish to call attention to the fact that in all this reciprocal leveling the aim has been to get correct results by elimination of error rather than by applying corrections for the constants. The recorded values of the constant *p*, as published in the various reports, often show a considerable change in a short period, which would create a doubt as to their value at any intermediate time. This liability to change also shows the advantage of completing the observations across one span before proceeding to another.

Incorporated in this report are the following tables and plates:

Table No. 1 gives the instrumental constants.

Table No. 2 gives the results of levels run.

Table No. 3 gives in detail the results of the platform work across the gorge.

Table No. 4 gives in detail the results of platform work at Elm Grove.

Table No. 5, list of U. S. P. B. M's.

Table No. 6, table of refraction (hourly), as found by 46 sets of reciprocal levels.

Plate 1, sketch showing the location of the platforms and of the line run on shore.

Plate 2, sketch showing the platform on Pelican Spit, P, in plan and elevation.

In Table 2 column 1 gives the bench marks; column 2, the distance in kilometres from the initial point; column 3, the direction; column 4, the successive differences of elevation between the bench marks and their mean; column 5, the residuals; column 6, the probable error *r* of the mean in column, 4, computed by the formula

$$r = 0.6745\sqrt{\frac{[v\,v]}{m\,(m-1)}}$$

column 7, the probable error R of the mean elevation of the B. M. to which it refers, as computed from the beginning of the line; column 8, the elevation referred to the plane of reference; column 9, corrections to be applied to column 8; column 10, the corrected elevation referred to the plane of reference; column 11, the initial of the observer.

Digitized by Google

TABLE NO. 1.—*Constants of instruments.*

Number of instrument.	Date.	*pn.*	*pi.*	P.	i.	i'.	I.	No. of vial.	v.	Computer.
		"	"	"	′ "	′ "	′ "		"	
Kern level:	1890.									
No. 1....	May 15	.....	.....	.....	13 50.58	13 51.01	27 41.59	3	1.67	G. Bagnall.
No. 1....	July 1	−4.26	−1.07	−2.69	.....	.....	.....	.....	.....	Do.
No. 5....	Mar. 25	.....	.....	.....	17 07.95	17 10.36	34 18.31	1	3.68	A. L. Johnson.
No. 5....	May 15	−0.58	−0.85	−0.72	.....	.....	.....	.....	.....	Do.
No. 5....	July 1	−0.60	−1.11	−0.85	.....	.....	.....	1	*2.55	Do.

* This value of one division of the bubble was found by a different method from that used in the previous determination, as explained in report.

pn and *pi* in the above table are the inequalities of the pivot rings with the telescope normal and inverted, respectively.

P is the mean of *pn* and *pi*.

i is the wire interval between the middle and upper wire.

i' is the wire interval between the middle and lower wire.

I is the sum of i and i'.

TABLE NO. 2.

Bench.	Distance.	Direction.	Difference of elevation.	v.	r.	R.	Elevation.	Rod connection.	Corrected elevation.	Observer.
	Kilos.									
Water table, Hendley Building	.....	.....	.....	.....	.....	.....	.....	.....	2,096.7	
U. S. P. B. M. No. 6	.....	.....	+1,194.0	.....	.....	.....	3,290.7	.....	3,290.7	B.
T. B. M. 16	.024	N.	−1,440.8	+0.4	0.3	.....	1,850.3	.....	1,850.3	J.
		S.	−1,440.0	−0.4	.....	.....	.....	.....	.....	J.
Mean	.....	.....	−1,440.4							
T. B. M. 17	1.037	N.	− 338.9	+0.9	0.4	.....	1,512.3	.....	1,512.3	J.
		S.	− 336.7	−1.3	.....	.....	.....	.....	.....	J.
		N.	− 338.4	+0.4	.....	.....	.....	.....	.....	J.
Mean	.....	.....	− 338.0							
T. B. M. 18	1.77	N.	− 670.4	−3.3	1.2	.....	838.6	.....	838.6	J.
		S.	− 676.8	+3.1	.....	.....	.....	.....	.....	J.
		N.	− 673.8	+0.1	.....	.....	.....	.....	.....	J.
Mean	.....	.....	− 673.7							
T. B. M. Q. (platform)	3.60	N.	+ 279.3	−0.8	0.5	.....	1,117.1	.....	1,117.1	J.
		S.	+ 277.7	+0.8	.....	.....	.....	.....	.....	J.
Mean	.....	.....	+ 278.5							
U. S. P. B. M. 7*	3.68	N.	+ 75.8	−0.1	0.3	1.4	1,192.8	.....	1,192.8	J.
		S.	+ 75.0	+0.7	.....	.....	.....	.....	.....	J.
		N.	+ 75.0	+0.7	.....	.....	.....	.....	.....	B.
		S.	+ 77.0	−1.3	.....	.....	.....	.....	.....	B.
Mean	.....	.....	+ 75.7							
T. B. M. Ft. Pt. *a*†	4.52	N.	+ 924.7	+1.0	0.6	.....	2,042.8	.....	2,042.8	J.
		S.	+ 926.7	−1.0	.....	.....	.....	.....	.....	B.
Mean	.....	.....	+ 925.7							
U. S. P. B. M. Ft. Pt. *b**	4.576	N.	− 675.1	−1.9	0.5	1.6	1,365.8	.....	1,365.8	J.
		S.	− 676.5	−0.5	.....	.....	.....	.....	.....	J.
		N.	− 679.0	+2.0	.....	.....	.....	.....	.....	B.
		S.	− 677.2	+0.2	.....	.....	.....	.....	.....	B.
Mean	.....	.....	− 677.0							
Platform G. G.	6.68	....	+ 779.6	+0.5	0.4	1.5	1,897.2	.....	1,897.2	J. and B
			+ 780.7	−0.6	.....	.....	.....	.....	.....	J. and B
Mean	.....	.....	+ 780.1							

*Not on direct line.

† This is a peg on line No. 2 from Q. to G. G. For rest of line see Ft. Pt. *a* and G. G., Table No. 3.

Digitized by Google

TABLE No. 2—Continued.

Bench.	Distance.	Direction.	Difference of elevation.	v.	r.	R.	Elevation.	Rod connection.	Corrected elevation.	Observer.
	Kilos.									
B. M. on Gorge Gauge *	6.79	....	+ 493.3	.....	.....	1.5	2,390.5	.....	2,390.5	B.
			+ 493.3	.....	.....	.....	.....	.....	.....	B.
Mean	.....	....	+ 493.3							
B. 1	7.74	....	− 730.2	+2.4	1.6	2.1	1,169.4	.....	1,169.4	J. and B.
			− 725.3	−2.5	.....	.....	.....	.....	.....	B.
Mean	.....	....	− 727.8							
B. 2†	.....	N.	− 90.1	−0.4	0.3	.....	1,078.9	.....	1,078.9	J.
		S.	− 90.8	+0.3	.....	.....	.....	.....	.....	B.
Mean	.....	....	− 90.5							
T. B. M. 20 R	8.54	N.	− 510.8	+1.1	0.3	.....	659.7	.....	659.7	J.
		S.	− 509.7	0.0	.....	.....	.....	.....	.....	J.
		N.	− 508.6	−1.1	.....	.....	.....	.....	.....	B.
Mean	.....	....	− 509.7							
U. S. P. B. M. 1	9.1	N.	+2,030.0	+0.5	0.4	2.2	2,690.2	.....	2,690.2	J.
		S.	+2,030.9	−0.4	.....	.....	.....	.....	.....	J.
Mean	.....	....	+2,030.5							
U. S. P. B. M. 8*	9.11	S.	− 873.8	−0.4	0.3	2.2	1,816.0	.....	1,816.0	B.
		N.	− 874.6	+0.4	.....	.....	.....	.....	.....	B.
Mean	.....	....	− 874.2							
T. B. M. 1	10.38	N.	−1,666.3	−0.3	0.2	.....	1,023.6	.....	1,023.6	J.
		S.	−1,666.9	+0.3	.....	.....	.....	.....	.....	J.
Mean	.....	....	−1,666.6							
U. S. P. B. M. 2*	.....	N.	+1,227.3	+0.4	0.3	2.3	2,251.3	.....	2,251.3	J.
		S.	+1,228.1	−0.4	.....	.....	.....	.....	.....	J.
Mean	.....	....	+1,227.7							
T. B. M. 2	11.78	N.	+ 398.4	−3.8	1.4	.....	1,418.2	.....	1,418.2	J.
		S.	+ 394.0	+0.6	.....	.....	.....	.....	.....	J.
		N.	+ 391.4	+3.2	.....	.....	.....	.....	.....	J.
Mean	.....	....	+ 394.6							
U. S. P. B. M. 3*	11.98	N.	+ 132.6	0.0	0.1	2.7	1,550.8	.....	1,550.8	J.
		S.	+ 132.5	−0.1	.....	.....	.....	.....	.....	J.
Mean	.....	....	+ 132.6							
T. B. M. 3b	12.84	N.	− 811.8	+1.0	1.4	.....	607.4	.....	607.4	J.
		S.	− 816.0	+5.2	.....	.....	.....	.....	.....	J.
		N.	− 806.9	−3.9	.....	.....	.....	.....	.....	J.
		N.	− 808.4	−2.4	.....	.....	.....	.....	.....	J.
Mean	.....	....	− 810.8							
T. B. M. 3c	13.00	....	+ 190.6	0.0	.....	.....	798.0	.....	798.0	J.
			+ 190.6	0.0	.....	.....	.....	.....	.....	J.
Mean	.....	....	+ 190.6							
T. B. M. 4	13.41	N.	− 182.5	−0.3	0.2	.....	615.2	.....	615.2	J.
		S.	− 183.1	+0.3	.....	.....	.....	.....	.....	J.
Mean	.....	....	− 182.8							
T. B. M. 5	14.52	N.	+ 297.9	+1.3	0.8	.....	914.4	.....	914.4	J.
		S.	+ 300.4	−1.2	.....	.....	.....	.....	.....	J.
Mean	.....	....	+ 299.2							
U. S. P. B. M. 4*	15.08	....	+ 643.4	.....	.....	3.1	1,557.8	.....	1,557.8	J.

* Not on direct line.
† This is on line No. 2 from G. G. to B. I. For rest of line see Table No. 3.

Digitized by Google

TABLE NO. 2—Continued.

Bench.	Distance.	Direction.	Difference of elevation.	v.	r.	R.	Elevation.	Rod connection.	Corrected elevation.	Observer.
	Kilos.									
T. B. M. 6 L	15.65	N.	− 185.4	+1.4	1.0	.....	730.4	.....	730.4	J.
		S.	− 182.5	−1.5	.....	.....	.....	.....	.....	J.
Mean			− 184.0							
T. B. M. 7	16.14	N.	− 214.0	+0.6	0.4	.....	517.0	.....	517.0	J.
		S.	− 212.8	−0.6	.....	.....	.....	.....	.....	J.
Mean			− 213.4							
T. B. M. 8	16.71	N.	+ 468.7	+3.4	1.2	.....	989.1	.....	989.1	J.
		S.	+ 472.8	−0.7	.....	.....	.....	.....	.....	J.
		N.	+ 474.9	−2.8	.....	.....	.....	.....	.....	J.
Mean			+ 472.1							
T. B. M. 9 R	17.27	N.	+ 335.6	+0.5	0.3	.....	1,325.2	.....	1,325.2	J.
		S.	+ 336.6	−0.5	.....	.....	.....	.....	.....	J.
Mean			+ 336.1							
T. B. M. 10	17.76	N.	− 45.6	−1.1	0.7	.....	1,278.5	.....	1,278.5	J.
		S.	− 47.8	+1.1	.....	.....	.....	.....	.....	J.
Mean			− 46.7							
T. B. M. 11 *m*	18.26	N.	+ 94.4	−0.6	0.4	.....	1,372.3	.....	1,372.3	J.
		S.	+ 93.2	+0.6	.....	.....	.....	.....	.....	J.
Mean			+ 93.8							
T. B. M. 12 *m*	19.02	N.	+ 78.1	−0.1	0.1	.....	1,450.3	.....	1,450.3	J.
		S.	+ 77.9	+0.1	.....	.....	.....	.....	.....	J.
Mean			+ 78.0							
T. B. M. 13 *m*	20.16	N.	− 358.8	+0.2	0.1	.....	1,091.7	.....	1,091.7	J.
		S.	− 358.4	−0.2	.....	.....	.....	.....	.....	J.
Mean			− 358.6							
T. B. M. 14 *m*	21.10	N.	− 56.5	−2.9	1.1	.....	1,032.3	.....	1,032.3	J.
		S.	− 62.2	+2.8	.....	.....	.....	.....	.....	J.
		S.	− 59.5	+0.1	.....	.....	.....	.....	.....	J.
Mean			− 59.4							
T. B. M. 15 platform A	21.50	N.	− 372.2	+0.3	0.2	.....	660.4	.....	660.4	J.
		S.	− 371.7	−0.2	.....	.....	.....	.....	.....	J.
Mean			− 371.9							
U. S. P. B. M. 5*	21.71	N.	+ 426.2	+0.5	0.3	3.7	1,087.1	.....	1,087.1	J.
		S.	+ 427.2	−0.5	.....	.....	.....	.....	.....	J.
Mean			+ 426.7							
T. B. M. at B. (platform)			+ 125.7	+0.1	0.1	.....	786.2	.....	786.2	J. and B.
			+ 125.8	0.0	.....	.....	.....	.....	.....	J. and B.
Mean			+ 125.8							
T. B. M. at C. (platform)			+ 361.1	−0.4	0.3	.....	1,146.9	.....	1,146.9	J. and B.
			+ 360.3	+0.4	.....	.....	.....	.....	.....	J. and B.
Mean			+ 360.7							
T. B. M. at D. (platform)			− 110.8	−0.3	0.2	.....	1,035.8	.....	1,035.8	J.
			− 111.4	+0.3	.....	.....	.....	.....	.....	B.
Mean			− 111.1							
T. B. M. at E. (platform)			+1,064.8	+0.7	0.5	.....	2,101.3	.....	2,101.3	J. and B.
			+1,066.1	−0.7	.....	.....	.....	.....	.....	J. and B.
Mean			+1,065.5							

* Not on direct line.

Digitized by Google

TABLE No. 2—Continued.

Bench.	Distance.	Direction.	Difference of elevation.	v.	r.	R.	Elevation.	Rod connection.	Corrected elevation.	Observer.
	Kilos.									
T. B. M. at F. (platform)			+ 129.7	−0.1	0.1		2,230.9		2,230.9	J. and B.
			+ 129.5	+0.1						J. and B.
Mean			+ 129.6							
B. M. on tide house at Hannas Reef			−1,026.4	−0.7	0.4	3.8	1,203.8		1,203.8	J.
			−1,027.7	+0.6						B.
Mean			−1,027.1							

TABLE No. 3.

LEVEL NO. 1, NORTH.

Platform and distances.	Date.	Hour.	Differences of elevation. Level No. 1.	Differences of elevation. Level No. 5.	Mean difference of elevation.	Means.
Q. and P. (1,417 meters)	June 19	9.00 a. m.	+964.9	+674.4	+819.7	
	June 19	9.55 a. m.	+969.4	+672.9	+821.2	+820.0
	June 19	10.30 a. m.	+966.2	+671.9	+819.1	
P. and G. G. (1,945 meters)	June 21	10.30 a. m.	+234.2	−322.6	− 44.2	
	June 21	11.00 a. m.	+246.8	−317.5	− 35.4	− 40.0
	June 21	12.00 m.	+241.2	−321.9	− 40.4	
G. G. and B. 1 (981 meters)	June 13	6.50 a. m.	−677.9	−783.6	−730.8	
	June 13	7.30 a. m.	−677.9	−783.6	−730.8	
		8.00 a. m.	−678.0	−791.4	−734.7	−731.8
		8.45 a. m.	−665.0	−788.7	−726.9	
		9.30 a. m.	−678.7	−793.6	−736.2	
Ft. Pt. and G. G. (1,884 meters)	June 17	2.15 p. m.	+164.7	−450.4	−142.9	
	June 17	3.00 p. m.	+162.2	−447.7	−142.8	
	June 17	3.40 p. m.	+162.4	−438.0	−137.8	
	June 17	4.30 p. m.	+139.2	−436.5	−148.7	−141.6
	June 22	6.30 a. m.	+129.0	−386.5	−128.8	
	June 22	7.30 a. m.	+112.9	−397.5	−142.3	−140.1 −143.1
	June 22	8.10 a. m.	+ 96.6	−394.9	−149.2	
G. G. and B. 2 (967 meters)	June 25	9.55 a. m.	−570.6	−701.6	−636.1	
		10.30 a. m.	−559.1	−707.3	−633.2	−635.1
		11.00 a. m.	−565.6	−706.5	−636.0	

LEVEL NO. 5, NORTH.

Platform and distances.	Date.	Hour.	Differences of elevation. Level No. 1.	Differences of elevation. Level No. 5.	Mean difference of elevation.	Mean.	Actual difference of elevation.
Q. and P. (1,417 meters)	June 19	4.45 p. m.	+676.6	+985.8	+831.2		
	June 19	6.00 p. m.	+674.0	+985.4	+829.7	+831.1	+825.6
	June 19	7.00 p. m.	+676.0	+989.0	+832.5		
P. and G. G. (1,945 meters)	June 21	7.00 a. m.	−334.6	+224.2	− 55.2		
	June 21	8.20 a. m.	−321.6	+215.0	− 53.3	− 52.0	−46.0
	June 21	9.00 a. m.	−320.6	+225.6	− 47.5		
G. G. and B. 1 (981 meters).	June 12	5.15 p. m.	−806.8	−654.3	−730.6		
	June 12	6.00 p. m.	−784.6	−664.9	−724.8		
	June 18	4.00 p. m.	−817.9	−637.1	−727.5	−728.7	−730.3
	June 18	5.00 p. m.	−813.4	−644.7	−729.1		
	June 18	6.00 p. m.	−823.9	−639.2	−731.6		
Ft. Pt. and G. G. (1,884 meters).	June 17	5.00 p. m.	−467.9	+147.7	−160.1		
	June 17	6.00 p. m.	−447.0	+134.5	−156.3		
	June 18	7.45 a. m.	−422.3	+118.1	−152.1		
	June 18	9.00 a. m.	−417.3	+115.6	−150.9	−150.4	
	June 18	9.30 a. m.	−430.1	+126.7	−151.7		
	June 18	10.00 a. m.	−409.6	+128.0	−140.8	−148.4	−145.0
	June 18	10.45 a. m.	−412.0	+130.7	−140.7		
	June 20	7.15 a. m.	−403.8	+117.8	−143.0	−146.5	
	June 20	8.00 a. m.	−415.7	+116.0	−149.9		
	June 20	9.00 a. m.	−390.8	+106.7	−146.6		
G. G. and B. 2 (967 meters).	June 25	4.30 p. m.	−713.2	−552.2	−632.7		
	June 25	5.00 p. m.	−709.7	−566.1	−637.9	−634.4	−634.8
	June 25	6.00 p. m.	−704.7	−560.6	−632.7		

Digitized by Google

TABLE No. 4.

LEVEL NO. 1, NORTH.

Platform and distances.	Date.	Hour.	Differences of elevation.		Mean difference of elevation.	Means.
			Level No. 1.	Level No. 5.		
A. and B. (400 meters) *.....	May 1	9.15 a. m.	+ 140.3	+ 117 6	+ 127.0	+ 127.7
	May 1	10.00 a. m.	+ 139.6	+ 11[illegible]	128.3	
B. and C. (420 meters) *.....	May 1	7.00 a. m.	+ 379.7	+ 349.0	[illegible] 364.4	+ 362.7
	May 1	8.00 a. m.	+ 380.7	+ 341.4	+ 361.1	
D. and E. (685 meters)	April 26	5.15 p. m.	+1,112.3	+1,032.0	[illegible],072.1	+1,072.9
	April 30	8.10 a. m.	+1,107.9	+1,039.8	+1,073.6	
E. and F. (693 meters)	April 28	2.30 p. m.	+ 181.2	+ [illegible] 2	+ 135.7	+ 136.3
	April 28	3.45 p. m.	+ 177.9	+ 9[illegible].8	+ 136.9	
Check levels.						
A. and C.....	May 1	5.50 a. m.	+ 526.4	+ 458.1	+ 492.3	+ 494.7
	May 1	6.30 a. m.	+ 539.2	+ 454.9	+ 497.1	
D. and F. (1,378 meters).....	April 28	5.30 p. m.	+1,395.2	+1,042.0	+1,218.6	+1,218.6

LEVEL NO. 5, NORTH.

Platform and distances.	Date.	Hour.	Differences of elevation.		Mean difference of elevation.	Means.	Actual difference of elevation.
			Level No. 1.	Level No. 5.			
A. and B. (400 meters)*	April 30	3.15 p. m.	+ 109.9	+ 138.6	+ 124.3	+ 123.8	+ 125.8
	April 30	4.00 p. m.	+ 109.9	+ 137.6	+ 123.3		
B. and C. (420 meters)*.	April 30	5.00 p. m.	+ 338.9	+ 376.7	+ 357.8	+ 358.7	+ 360.7
	April 30	5.30 p. m.	+ 344.9	+ 374.1	+ 359.5		
D. and E. (685 meters).	April 29	8.15 a. m.	+1,021.6	+1,093.3	+1,057.4	+1,058.1	+1,065.5
	April 29	9.00 a. m.	+1,021.0	+1,096.5	+1,058.7		
E. and F. (693 meters).	April 29	3.00 p. m.	+ 92.3	+ 152.7	+ 122.5	+ 122.9	+ 129.6
	April 29		+ 89.6	+ 156.9	+ 123.3		
Check levels.							
A. and C.....	April 30	6.10 a. m.	+ 431.5	+ 528.2	+ 479.8	+ 483.3	+ 489.0
		6.45 a. m.	+ 428.5	+ 544.9	+ 486.7		
D. and F. (1,378 meters)	April 29	5.30 p. m.	+1,028.6	+1,335.3	+1,182.0	+1,182.0	+1,200.3

* These distances are only approximate.

TABLE No. 5.

U. S. P. B. M. No. 1, top of first anchor bolt west of entrance to Bolivar Light-House.

U. S. P. B. M. No. 2, is a copper bolt leaded into the top of a stone 6 by 6 inches, 3 feet long and projecting up ¼ inch. It is in the center of a counter sunk hole 2 inches in diameter by three-quarter inches deep, making the top of the bolt one-half inch below the surface of the stone. This stone is set on a bed of broken concrete in a hole dug to a depth of 3 feet, and was well tamped around. It is located 50 feet west of south side of the old Government quarters building.

U. S. P. B. M. No. 3, resembles U. S. P. B. M. No. 2, and is also set on a bed of dry concrete. It is located by the following sextant angles: B. P. and H. M., 86° 11′ 00″; H. M. and M., 72° 08′; M. and Sealy Hospital, 300°; H. M. and west end of the old Government building, 82°.

U. S. P. B. M. No. 4, is similar to the last two. It is located by the following sextant angles: H. M. and water tower, 71° 20′ 30″; water tower and L. H., 10° 53′; L. H. and P., 87° 32′ 30″; P. and Hanna Reef tide house, 60° 31′; tide house and H. M. 129° 42′ 30″.

U. S. P. B. M., No. 5 resembles Nos. 2, 3 and 4, but it is built into a mass of concrete mixed in a hole 4 feet deep. It is located near the boundary fence of Siever's farm, which runs from the house to the bay. The following sextant angles locate it: Tide house and L.H., 146° 30′ 10″; L. H. and P., 18° 7′; P. and meeting house, 61° 35′.

U. S. P. B. M. No. 6, is a copper bolt let horizontally into the north side of the northeast granite column of the Hendley building flush with its face.

U. S. P. B. M. No. 7, resembles Nos. 2, 3, 4, and 5, and is set in concrete like No. 5. It is located about 20 feet south of the jetty track on the point of Galveston Island, in line with the east side of the Quarantine storehouse.

Digitized by Google

Digitized by Google

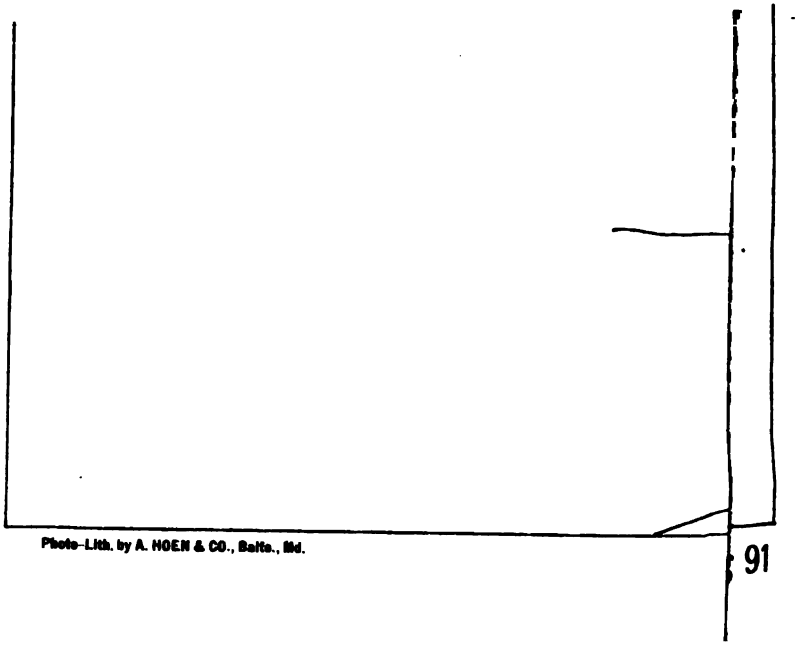


Photo-Lith. by A. HOEN & CO., Balto., Md.

Digitized by Google

Digitized by Google

Photo-Lith. by A. HOEN & CO., Balto., Md.

Eng 91

Digitized by Google

U. S. P. B. M. No. 8, is similar to No. 7, and set in the same manner in concrete. It is located 50 feet south-southwest of U. S. P. B. M. No. 1, and 20 feet north of L. H. fence.

Fort Point *b.*, is the northeast bolt of the northwest bearing pile of the light-house.

TABLE No. 6.—*Refraction.*

Hour.	Reciprocal observations.	Refraction per metre.
		Millimetre.
7 a. m. to 8 a. m.	24	.0217
8 a. m. to 9 a. m.	24	.0211
9 a. m. to 10 a. m.	28	.0170
10 a'm. to 11 a. m.	32	.0142
11 a. m. to 12 m.	8	.0138
3 p. m. to 4 p. m.	16	.0078
4 p. m. to 5 p. m.	12	.0076
5 p. m. to 6 p. m.	20	.0080
6 p. m. to 7 p. m.	20	.0105

Before concluding, I wish to acknowledge the services of Mr. A. L. Johnson, assistant engineer, to whose assistance the success of the work is largely due. Thanks are also due the other members of the parties for their faithful services.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF GALVESTON HARBOR, TEXAS, FOR FISCAL YEAR ENDING JUNE 30, 1891.

[Compiled from statements furnished by Julius Runge, esq., president of the Galveston Cotton Exchange, and N. W. Cuney, esq., collector of the port of Galveston.]

Steam vessels entered		342
Sailing vessels entered		139
Total		481
Steam vessels cleared		345
Sailing vessels cleared		96
Total		441
Total tonnage of vessels entered	tons	544, 862
Total tonnage of vessels cleared	do	529, 058
Total tonnage		1, 073, 920
Amount of revenue collected		$174, 489. 92

Amount and value of freight shipped.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (1,114,133 bales)	258, 638	$53, 603, 000	$4, 315, 000
Cotton-seed cake and oil	44, 182	1, 043, 000	244, 000
Ore	6, 923	623, 000	32, 000
Wool	6, 847	2, 914, 000	88, 000
General merchandise	14, 028	1, 451, 000	112, 250
Total	330, 618	59, 634, 000	4, 821, 250

Digitized by Google

Comparative statement of commercial statistics of the port of Galveston, Tex., for the fiscal years ending June 30, 1887, 1888, 1889, 1890, and 1891.

Years.	Vessels entered.		Vessels cleared.		Tonnage.			Cotton shipped.	Other merchandise.	Revenue collected.
	Steam.	Sailing.	Steam.	Sailing.	Entered.	Cleared.	Total.			
								Tons.	*Tons.*	
1887.....	250	296	256	238	446,711	444,801	891,512	.....	.....	$172,894
1888.....	259	231	249	193	447,144	432,588	879,732	.....	.....	234,9[illegible]
1889.....	250	131	244	124	416,468	403,896	820,364	.....	.....	153,040
1890.....	302	145	304	118	501,695	492,677	999,372	223,486	86,023	131,613
1891.....	342	139	345	96	544,862	529,058	1,073,920	258,638	71,980	174,489

U 2.

IMPROVEMENT OF SHIP CHANNEL IN GALVESTON BAY, TEXAS.

The present project for this improvement, adopted in 1871 and modified in 1877, consists in excavating a channel at least 12 feet deep and with a width at bottom of 100 feet through Galveston Bay from Bolivar Channel to Morgan Cut, a distance of about 18.9 miles, the average natural depth in the bay on the line of this channel being about 8½ feet at mean low tide. This channel is one link in a water way connecting Houston with the Gulf of Mexico, of which the other links are the private works at Morgan Point and its approaches on the bay side, San Jacinto River, and Buffalo Bayou. The works at Morgan Point comprise Morgan Canal and Morgan Cut. Morgan Canal is cut through a peninsula called Morgan Point; it connects San Jacinto River with Galveston Bay. Morgan Cut is a dredged prolongation of the canal extending out into Galveston Bay for a distance of 5 miles. Both the canal and cut were excavated by the Buffalo Bayou Ship Channel Company, a corporation chartered by the State of Texas. This company agreed in 1881 to surrender to the United States its works at Morgan Point, together with its charter and rights under it, upon the completion by the Government of the ship channel in Galveston Bay. The acts of Congress appropriating money for the work read, "Improving ship channel in Galveston Bay, Texas, from Morgan Cut to Bolivar Channel." For more detailed information as to the work done by the Buffalo Bayou Ship-Channel Company attention is invited to Appendix T 2 to the Annual Report of the Chief of Engineers for 1887, and to Appendix V 2 to the Annual Report for 1889.

The excavation by the United States of a channel up to Morgan Cut was completed by the 20th of July, 1889, and the company was then called upon to execute its agreement of January 22, 1881, to transfer to the United States its works at Morgan Point. The claim for compensation advanced by the company, and the position of the United States Government in the matter, appear by the correspondence printed on pages 1555–1557 of Appendix V 2 to the Annual Report, 1889.

The river and harbor act of Congress, approved September 19, 1890, appropriated as follows:

Improving and maintaining a ship channel in Galveston Bay, Texas, from Bolivar Channel, through Morgan Cut and Morgan Channel, constructed through Morgan Point, to the San Jacinto River, forty thousand dollars.

Section 16 of the same act provides:

That whereas the United States, in compliance with its obligation to the Buffalo Bayou Ship-Channel Company, has constructed a ship channel through Galveston

Digitized by Google

Bay, from the Bolivar Channel to the channel constructed by the said Buffalo Bayou Ship Channel, known as Morgan Cut, for vessels of twelve feet draught, it is therefore declared that the ship channel through Galveston Bay from Bolivar Channel to the point where the San Jacinto River enters what is known as the Morgan Channel, excavated through Morgan Point, is now the property of the United States and is declared to be free to navigation; and the Secretary of War is hereby directed to keep said ship channel free to navigation: *Provided*, That the Secretary of War shall first ascertain by a commission of United States engineers, to be by him designated for that purpose, and whose report shall be subject to his approval, the present value of any portion of said channel which may have been constructed by the Buffalo Bayou Ship Channel Company agreed to be paid for by the United States in the act of Congress of March third, eighteen hundred and seventy-nine. But, in appraising the value thereof, no account shall be taken of the charter granted to said company by the legislature of Texas, or of any franchise right claimed thereunder, and the amount so ascertained and certified to be correct by the Secretary of War shall be paid to said Buffalo Bayou Ship Channel Company, and is hereby appropriated out of any money in the Treasury not otherwise appropriated.

In accordance with the requirements of section 16, a Commission, appointed by paragraph 5, Special Orders No. 66, Headquarters, Corps of Engineers, September 30, 1890, met December 2, and rendered a report under date of December 4, 1890. This report was approved by the War Department and transmitted by it to the proper department of the Government for payment, but the company has not yet turned over its works, etc., to the United States. In consequence, operations for the past fiscal year have consisted in maintaining the beacons which mark the ship channel, and in making tidal observations in Galveston Bay.

The work of dredging the channel, which was suspended in 1883, was resumed in February, 1888, and a 12-foot channel completed from Bolivar Channel to Morgan Cut, July 20, 1889, as already stated, since which date no dredging has been done. The average depth of the excavation was 13.15 feet at mean low tide.

The condition of the dredged channel at the close of June, 1889, is described in the Annual Report for that year as follows:

A resurvey of the entire length of the channel was made in June, [1889]. It shows a marked deterioration of the channel through the lower bay, where the greatest length of time has elapsed since the work was done. Considering the portion of the channel, 9.93 miles in length, extending from Bolivar Channel to Red Fish Bar, the average length of time which had elapsed since the execution of the work was 10 months. The average depth of the bay before the excavation was 8.63 feet. The average depth of the channel after excavation was 13.15 feet, making an average depth of excavation of 4.52 feet. The average depth of the channel was found in June to be 11.61 feet, which shows an average fill of 1.54 feet or 34 per cent., in 10 months. In my annual report for 1887 I stated that if the channel between Bolivar Channel and Red Fish Bar be maintained at the full depth of 12 feet it will require the removal each year of not less than 30 per cent. of the amount originally excavated. (See Annual Report Chief of Engineers for 1887, page 1420.) These views have been fully confirmed.

In the upper bay the average period which had elapsed since the execution of the work was in June, only 2 months, and no important deterioration was detected by the survey.

An examination of the channel made in June, 1890, showed a ruling depth of 10 feet, the dredged depth which remained in June, 1889, in the lower bay (Boliver Channel to Red Fish Bar), having shoaled 40 per cent., while the depth of excavation in the channel in the upper bay (Red Fish to Morgan Cut) had, in 14 months, shoaled to an extent represented by 24 per cent. of the original excavation.

An examination of the channel from Bolivar Channel to Morgan Cut, made June 23 last, disclosed a ruling depth for that distance of 9 feet, the average depth being somewhat more.

The percentages of decrease in depth are more particularly stated in the report herewith of Mr. Gerald Bagnall, assistant engineer.

Digitized by Google

No commercial statistics can be given to apply to this work. It is believed by many of the best informed men of Houston that the advantages to be derived from enabling sea-going ships to reach Houston by way of the ship channel and Buffalo Bayou will be vastly greater than the cost of making and maintaining the channel. The annual report upon Buffalo Bayou gives as full statistics of the freight carried upon that stream as could be obtained. It is carried in barges drawing 5 feet when fully loaded and towed by tugs drawing 7 feet and less. These cross Galveston Bay, but the depth of water is already sufficient for them. A large proportion of this freight would be loaded directly upon sea-going ships if they visited Houston. One item of shipment by water down Buffalo Bayou from Houston during the past fiscal year was 297,592 bales of cotton, valued at about $15,908,535, an increase over the shipments of last year of 54,492 bales, and consequent increase in value of about $2,638,000.

The estimated cost of the improvement, revised in 1888, is $740,108.22. The aggregate of appropriations to July 1, 1891, is $586,500, including in this latter sum the $40,000 appropriated by act of September 19, 1890. But the last-named sum is appropriated for improving and maintaining the channel from Boliver Channel through Morgan Cut and Morgan Canal to San Jacinto River.

The cost of deepening Morgan Cut and of executing other work at the cut and in the canal can not be stated until those works are in the hands of the United States and a thorough survey made of them. The $40,000, however, will not suffice for excavating the cut to the depth required and for work in and at the canal.

A survey of Galveston Ship Channel from Boliver Channel to Morgan Cut is also needed from which to arrive at the cost of further work required upon that stretch.

I am restricted, at present, to submitting as an estimate of the amount that will be required to complete the work from Bolivar Channel to Morgan Cut, the difference between the revised estimate of 1888 and the sums appropriated to date (including that of September, 1890), viz., $154,608.22.

The annual cost of maintaining the channel after it is once excavated was set by my predecessor in charge at $80,000, an estimate in which I concur.

The annual reports for 1889 and 1890 contained an estimate of $200,000 for continuing the work during the year for which the estimate was made, that amount being then regarded as sufficient to complete the excavation and maintain it for one year. Delay in resuming the work of dredging adds, as may be expected, to the cost of excavation to the plane required, on account of the annual shoaling. I therefore submit, on the foregoing basis, an estimate of $200,000 for the fiscal year ending June 30, 1893.

Total expended on this improvement to June 30, 1890	$528,686.54
Total expended during fiscal year ending June 30, 1891	7,541.89
Original estimated cost of this work as revised in 1888	740,108.22
Aggregate amount appropriated to July 1, 1891	586,500.00
Amount expended to July 1, 1891	536,228.43
The amount required for maintenance after the completion of the original excavation (annually)	80,000.00

The work is located in the collection district of Galveston. The light-houses on or near the line of the work are at Bolivar Point, Fort Point, Half-Moon Shoal, and Redfish Bar. The amount of revenue collected at the port of Galveston during the fiscal year ending June 30, 1891, was $174,489.92.

Digitized by Google

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING SHIP CHANNEL IN GALVESTON BAY, TEXAS.

By act approved—	
March 3, 1875	$25,000
August 14, 1876	72,000
June 18, 1878	75,000
March 3, 1879	80,000
June 14, 1880	50,000
March 3, 1881	50,000
By act passed August 2, 1882	94,500
By act of August 11, 1888	100,000
By act of September 19, 1890	40,000
Total	586,500

Money statement.

July 1, 1890, balance unexpended	$17,813.46
Amount appropriated by act approved September 19, 1890	40,000.00
	57,813.46
June 30, 1891, amount expended during fiscal year	7,541.89
July 1, 1891, balance unexpended	50,271.57
July 1, 1891, outstanding liabilities	137.90
July 1, 1891, balance available	50,133.67
Amount that can be profitably expended in fiscal year ending June 30, 1893 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	200,000.00

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

GALVESTON, TEX., *June 28, 1891.*

SIR: I have the honor to make the following report on the improvement of ship channel in Galveston Bay for the fiscal year ending June 30, 1891.

The only work done during the year was the maintenance of beacons which were repaired and painted as far as Red Fish, with the exception of tripods Nos. 8 and 9, these latter having been knocked down by some boat. The schooner *Andrew Boden* was employed for this work in conjunction with the inspection of tide gauges from January 5, 1891 to February 16, 1891, and from April 24, 1891 to June 30, 1891.

An examination of the channel was made on June 23, 1891, and a considerable filling of the cut found to have taken place during the year. The percentage of decrease in depth as calculated from the original excavation grows less each year, but is almost constant when considered with reference to the depth at the beginning of the different years. In the lower bay the percentages of decrease during the years ending June 30, 1889, 1890, and 1891, as compared with the original exavation were 31, 60, and 74 per cent., respectively, while the annual decrease of the channels existing at the beginning of the same years was 34, 39, and 34 per cent., respectively. In the upper bay during the years ending June 30, 1890 and 1891, the decrease as referred to the original excavation was 24 and 44 per cent., respectively, while the percentages of decrease in the depth of the channels existing at the beginning of the same years were 24 and 26 per cent., respectively.

The ruling depth from Bolivar Channel to Morgan's cut is now 9 feet at mean low tide, the average depth being somewhat more.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

Digitized by Google

REPORT OF COMMISSION ON THE VALUE OF CHANNEL CONSTRUCTED BY THE BUFFALO BAYOU SHIP CHANNEL COMPANY IN GALVESTON BAY, TEXAS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 4, 1890.

GENERAL: The Commission constituted by paragraph 5, Special Orders No. 66, Headquarters, Corps of Engineers, September 30, 1890, has the honor to submit the following report:

The Commission met at Galveston, Tex., on December 1, 1890, pursuant to the call of its presiding officer, all the members being present.

Notices of the date and place of meeting of the commission had previously been inserted in the Galveston News and Houston Post.

At the meeting, December 1, the following letter of instructions was read:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington D. C., September 30, 1890.

COLONEL: The river and harbor act approved September 19, 1890, in section 16, provides as follows:

"SEC. 16. That whereas the United States, in compliance with its obligation to the Buffalo Bayou Ship Channel Company, has constructed a ship channel through Galveston Bay from the Bolivar Channel to the channel constructed by said Buffalo Bayou Ship Channel Company, known as Morgan's Cut, for vessels of twelve feet draught, it is therefore declared that the ship channel through Galveston Bay from Bolivar Channel to the point where the San Jacinto River enters what is known as the Morgan Channel, excavated through Morgan's Point, is now the property of the United States and is declared to be free to navigation; and the Secretary of War is hereby directed to keep said ship channel free to navigation: *Provided*, That the Secretary of War shall first ascertain by a commission of United States Engineers to be by him designated for that purpose, and whose report shall be subject to his approval, the present value of any portion of said channel which may have been constructed by the Buffalo Bayou Ship Channel Company, agreed to be paid for by the United States in the act of Congress of March third, eighteen hundred and seventy-nine, but in appraising the value thereof no account shall be taken of the charter granted to said company by the legislature of Texas, or of any franchise right claimed thereunder, and the amount so ascertained and certified to be correct by the Secretary of War shall be paid to said Buffalo Bayou Ship Channel Company, and is hereby appropriated out of any money in the Treasury not otherwise appropriated."

The Commission provided for in the above quoted section is constituted by authority of the Secretary of War by paragraph 5 of Special Orders No. 66, Headquarters, Corps of Engineers, September 30, 1890, and you are the presiding officer.

The duty required of the Commission is clearly indicated by the act, a copy of which is inclosed.

As early a report as is consistent with the proper consideration of the subject committed to the Commission is desired.

* * * * * * *

By command of Brigadier-General Casey:
Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Col. C. B. COMSTOCK,
Corps of Engineers.

The Commission devoted the 1st and 2d of December to hearing statements from Messrs. E. W. Cave, president, and J. J. Atkinson, superintendent, of the Buffalo Bayou Ship Channel Company, and of others interested in the navigation of that company's channel, and on December 3 examined the works of that company at Morgan's Cut and Morgan's Point.

Section 16 of the act of September 19, 1890, confines consideration of the portion of the ship channel whose value is to be estimated by the commission, to Morgan's Channel through Morgan's Point, 3,347 feet long, and Morgan's Cut, the latter extending southward from Mor-

Digitized by Google

Digitized by Google

Photo-Lith. by A. H

Digitized by Google

gan's Point for about 4.8 miles into Galveston Bay. (See Appendixes H and I.)

The portion of the channel excavated through the point is generally known as Morgan's Canal, and that in the bay as Morgan's Cut. (Please see sketch herewith.)

In deciding what is the present value of the foregoing works executed by the Buffalo Bayou Ship Channel Company, the only method which admits of a definite estimate consists in assuming that the United States desires to obtain a ship channel from Bolivar Channel to Houston, on Buffalo Bayou, and that the value of the company's works is measured by the amount of saving to the United States which would result from the existence of those works in the prosecution of such a project.

As a matter of fact, the United States Government has already dredged a ship channel to a width of 100 feet and depth of over 12 feet through Galveston Bay from Bolivar Channel to Morgan's Cut, and it has also in execution a project to afford a channel about 100 feet wide and 12 feet deep in Buffalo Bayou from Houston to the mouth of Simm's Bayou. From the last-named point, down Buffalo Bayou to the San Jacinto and thence to Morgan's Point, deep water is found, one small shoal on which there is about 9 feet at low water excepted.

A survey made in November last, under the direction of the commission, shows the present condition of Morgan's Cut and Canal, and comparison of the resulting map with the map from a survey of the canal and cut made in 1877, under direction of Capt. C. W. Howell, Corps of Engineers, and with the statements of Messrs. Cave and Atkinson, which statements are hereto appended, affords the data for ascertaining how much of the cut and canal remains.

Morgan's Cut has shoaled heavily since it was originally made and, indeed, at its lower end all signs of dredging have almost disappeared, but in going towards Morgan's Point the dredged channel becomes more marked until at a distance of about 23,000 feet from the lower end of the cut there is a well-defined channel. The amount of dredging which would be required to give this part of the channel the dimensions it now has is estimated at 264,263 cubic yards, and the present cost of executing such dredging is the present value to the United States of this portion of the channel.

The question of the value of the channel through Morgan Point (canal) is complicated by the fact that this channel has, under the scour of currents through it, increased its average section over that which was originally dredged by something like 82 per cent. If no work had been done by the company at this point, and if the United States Government now desired to excavate rapidly this canal, it would probably make the excavation almost entirely by dredging. On the other hand, if appropriations were scattered over several years, some of the dredging might be saved by waiting for the scour of the current. The question, how much dredge work would be saved by this scour were the United States to do the work, is one very difficult to answer, and it seems just to the company to give it the benefit of the uncertainty.

The company claims to have dredged a channel which, in 1876—the date at which it ceased work on the canal and cut—was 180 feet wide and 16 to 17 feet deep, leaving behind the dredge a clear channel 14 feet deep. The survey made under the direction of the Commission in November, 1890, shows that these dimensions are now largely exceeded throughout the canal. The United States survey of 1877 shows that

Digitized by Google

this width, 180 feet, was then considerably exceeded at some places while at others it was not quite equaled. As it is not probable that the width diminished between 1876 and the date of the survey in 1877, the Commission has thought it but just, in estimating the value of this portion of the channel, to take as the width of the excavation to be allowed 180 feet where the width shown on the map of 1877 was 180 feet or more, and the actual width shown on the same map where it is equal to or less than 180 feet. Then, basing the calculation on a 12-foot channel, with these widths at the water surface, assuming an excavation of 13 feet to allow for operation of dredging machines, and with side slopes of 1 upon 3, the volume to be allowed has been computed.

It is the opinion of the Commission that the estimate based upon the figures given in the preceding paragraph is fair, if not liberal. This amount of excavation is 273,706 cubic yards, and what it would now cost is the present value of that part of the company's channel.

It is possible that a less amount of dredging might suffice if the work were to be now undertaken and if it were extended over several years so as to utilize the scour of the current, but this view of it would be less favorable to the company. The aggregate amount of dredging therefore which would be saved to the United States by the existence of the present channels at Morgan Cut and Morgan Canal is estimated at 537,969 cubic yards. It is believed that it could now be done for 15 cents per cubic yard, and hence the Commission estimates the present value of this dredging at $80,695.35.

The old revetment of the banks of the canal is now practically worthless. The company, however, in 1890, put in 4,226 linear feet of new revetment whose estimated cost is $2.75 per foot, or, in all, $11,621.50. Adding this to the sum estimated for dredging, there results for the present value of the channel on which the Commission is required to report $92,316.85, and this amount is submitted as the appraised value.

The canal at Morgan Point is excavated through a tract of land 500 feet wide, this width including that of the canal. The Commission is unable to determine whether Congress intended to have the value of the land included in the estimate and hence does not so include it. Its area, excluding the canal, is about 25 acres and its real value does not exceed $10 per acre, or $250 in all. The company has constructed a timber groin extending into San Jacinto River just above the entrance to the canal. The Commission regards this groin as of doubtful utility and, although its cost was about $2,400, does not deem it of present value.

Affidavits of Mr. Cave, president, and Mr. Atkinson, superintendent, as to the amount of work done by the company, and copies of correspondence relating to the subject, and other papers, are herewith inclosed as appendixes A, B, C, D, E, F, G, H, and I.

Respectfully submitted.

C. B. COMSTOCK,
Colonel of Engineers, and Bvt. Brig. Gen.
CHAS. J. ALLEN,
Major, Corps of Engineers.
WM. C. LANGFITT,
First Lieut., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Digitized by Google

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 18, 1890.

Respectfully submitted to the Secretary of War.

This Commission was appointed by the Secretary of War in accordance with requirements of section 16 of the river and harbor act approved September 19, 1890.

The Commission reports the present value of the channel constructed by the Buffalo Bayou Ship Channel Company, known as Morgan Cut and Morgan Canal, to be $92,316.85.

Under the terms of the act above referred to the action of the Secretary of War upon this appraisal is required.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *January 6, 1891.*

The within report is approved, and the amount of $92,316.85, found by the Commission as the appraised value of the channel, is, under the provisions of section 16 of the river and harbor act of September 19, 1890, certified to be correct.

L. A. GRANT,
Assistant Secretary of War.

A.—SWORN STATEMENT OF MR. E. W. CAVE, PRESIDENT OF THE BUFFALO BAYOU SHIP CHANNEL COMPANY.

The Buffalo Bayou Ship Channel Company commenced work at Morgan Point about 1870. The ground was about 3 feet above the water surface. The first cut was made with a dredge and was about 35 feet wide, working from the river down. The excavation was made to 8 or 9 feet, resulting in a 6-foot depth. A derrick was then used by which the cut was then widened to about 70 feet, with a 9-foot depth in channel In the same way a narrow channel was excavated into the bay, from three-fourths to a mile long, and about 50 feet wide, with about 6 feet of water at mean tide. On account of wash a revetment of sheet-piling was put in on the east side of about 1,500 feet in length. I am unable to state the cost of this work, as the plant and expense were both involved in the Bayou works

The above work was continued with more or less intermission until about July, 1874, when Mr. Charles Morgan commenced work for the company.

E. W. CAVE,
President Buffalo Bayou Ship Channel Company.

Personally appeared before me, a notary public in and for the city and county of Galveston, State of Texas, this 2d day of December, 1890, the above-named E. W. Cave, who, being duly sworn, says that the above statement is true to the best of his knowledge and belief.

[SEAL.]

C. M. MASON,
Notary Public for Galveston County, State of Texas.

B.—SWORN STATEMENT OF MR. J. J. ATKINSON, SUPERINTENDENT OF THE BUFFALO BAYOU SHIP CHANNEL COMPANY.

When I took charge of the work at Morgan Point in 1874, there existed a channel about 70 feet wide at the water surface and about 6 feet deep through the land. This was carried through to the waters of the bay by a narrow channel of sufficient depth for a light-draft tug. From that time the work was prosecuted diligently and a canal through Morgan Point was cut 180 feet wide by 14 feet deep behind the dredge.

Digitized by Google

The bucket worked to 16 or 17 feet depth, but the sliding in of the loose material reduced this to 14 feet. A similar cut was made in the bay about 100 feet wide by 16 to 17 feet, the sliding in of the loose material reducing the navigable depth to 14 feet as before. This work was done between July, 1874, and October, 1876. A revetment was put in on both sides of the canal in the year 1875. This was renewed for a length of —— feet in 1890, which renewal cost about $2.75 per foot. Since the first completion of the channel in 1876 no dredging has taken place, except for about one-half mile from the south end of the canal through the land out into the bay, in 1879, at which time the Morgan Company's steamships were using the channel. The amount of this was about —— cubic yards. The total amount of excavation from July, 1874, to October, 1876, was about 1,554,642 cubic yards including work done at Red Fish Bar, but excluding land excavation at Morgan Point. The approximate amount done at Red Fish Bar was about 500,000 cubic yards. There were at least three dredges at work in the cut from March to October, 1876, of which no record is on hand now.

J. J. ATKINSON,
Superintendent.

Personally appeared before me, a notary public in and for the city and county of Galveston, State of Texas, this 2d day of December, 1890, the above-named J. J. Atkinson, who being duly sworn says that the above statement is true to the best of his knowledge and belief.

[SEAL.]

C. M. MASON,
Notary Public for Galveston County, State of Texas.

C.—LETTER OF LIEUTENANT WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., October 28, 1890.

SIR: An act passed during the last session of Congress entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved September 19, 1890, contains the following clause:

"SEC. 16. That whereas the United States, in compliance with its obligation to the Buffalo Bayou Ship Channel Company, has constructed a ship channel through Galveston Bay from the Bolivar Channel to the channel constructed by said Buffalo Bayou Ship Channel Company, known as Morgan Cut, for vessels of twelve feet draught, it is therefore declared that the ship channel through Galveston Bay from Bolivar Channel to the point where the San Jacinto River enters what is known as the Morgan Channel, excavated through Morgan Point, is now the property of the United States and is declared to be free to navigation, and the Secretary of War is hereby directed to keep said ship channel free to navigation: *Provided*, That the Secretary of War shall first ascertain by a Commission of United States Engineers to be by him designated for that purpose, and whose report shall be subject to his approval, the present value of any portion of said channel which may have been constructed by the Buffalo Bayou Ship Channel Company, agreed to be paid for by the United States in the act of Congress of March third, eighteen hundred and seventy-nine, but in appraising the value thereof no account shall be taken of the charter granted to said company by the legislature of Texas, or of any franchise right claimed thereunder, and the amount so ascertained and certified to be correct by the Secretary of War shall be paid to said Buffalo Bayou Ship Channel Company, and is hereby appropriated out of any money in the Treasury not otherwise appropriated."

The Commission mentioned therein has been appointed by Special Orders No. 66, dated Headquarters, Corps of Engineers, Washington, D. C., September 30, 1890, and will meet about November 28, next, at the U. S. Engineer office in Galveston. As soon as known, you will be notified of the exact date of the meeting.

The representatives of your company are invited to appear before the Commission and to lay before it such matters as may be desired by your company pertinent to the inquiry.

In the meantime the Commission would desire from you as soon as convenient the estimate of your company in detail of the "present value of any portion of said channel which may have been constructed, etc." This should be in writing and addressed to "Col. C. B. Comstock, president of the Commission, care U. S. Engineer office, Galveston, Tex.," to whom all official communications should be addressed.

In addition to the above, will you kindly send, as soon as possible, a description of the right of way pertaining to the work, so that it can be located?

Digitized by Google

It is proposed, for the information of the Commission, to make a more or less rapid survey of the cut and canal at Morgan Point.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieut., Corps of Engineers,
Member of Buffalo Bayou Ship Channel Commission.

Mr. E. W. CAVE,
President Buffalo Bayou Ship Channel Company.

D.—LETTER OF MR. E. W. CAVE, PRESIDENT BUFFALO BAYOU SHIP CHANNEL COMPANY.

OFFICE BUFFALO BAYOU SHIP CHANNEL COMPANY,
Houston, Tex., November 1, 1890.

SIR: I have the honor to acknowledge receipt of your favor of 28th ultimo.

I beg leave to state that the matters named therein will have due attention. Awaiting further notice as stated,

Very respectfully, your obedient servant,

E. W. CAVE,
President.

Lieut. WM. C. LANGFITT,
Corps of Engineers, U. S. A.,
Member of Commission of United States Engineer Officers.

E.—LETTER OF LIEUTENANT WILLIAM C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 5, 1890.

SIR: Referring to your reply of the 1st instant to my letter of the 28th ultimo, I would ask that the description of the right of way requested in my letter be sent me as soon as possible.

I take the liberty of again making this request, as I am not sure from the tenor of your reply that you understood that the description was wanted with as little delay as possible, and also because the survey mentioned in my letter is now under way and it is desirable that the party locate the right of way on the ground before conclusion of the work.

Will you kindly notify me by return mail when to expect it?

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieutenant, Corps of Engineers,
Member of Buffalo Bayou Ship Channel Commission.

E. W. CAVE, Esq.,
President Buffalo Bayou Ship Channel Company.

F.—LETTER OF MR. E. W. CAVE, PRESIDENT BUFFALO BAYOU SHIP CHANNEL COMPANY.

OFFICE OF BUFFALO BAYOU SHIP CHANNEL COMPANY,
Houston, Tex., November 6, 1890.

SIR: I have the honor to acknowledge receipt of your favor of 5th instant.

In reply will state that the metes and bounds of the right of way of this company at Morgan Point are as follows:

"Beginning on the north shore of Morgan Point at a point 500 feet west from the west side of W. Gundas house, or 616 feet west from Morgan's old wharf, or 20 feet west from the Pilot Lone Tree; thence westward along the shore, 500 feet to a point 64 feet east from the fence now standing (October 12, 1869); thence southwardly through what is known as the Meadow or Flat, between parallel lines, to the south shore of Morgan Point."

Very respectfully, your obedient servant,

E. W. CAVE,
President.

Lieut. WM. C. LANGFITT,
Corps of Engineers, U. S. A.,
Member Buffalo Bayou Ship Channel Commission.

Digitized by Google

G.—LETTER OF MR. E. W. CAVE, PRESIDENT BUFFALO BAYOU SHIP CHANNEL COMPANY.

OFFICE BUFFALO SHIP CHANNEL COMPANY,
Houston, Tex., November 27, 1890.

DEAR SIR: Replying to your letter dated October 28, 1890, I have to say that the Buffalo Bayou Ship Channel Company is unable to recognize that section 16 of the act passed during the last session of Congress entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved September 19, 1890, has any efficiency, validity, or effect.

You will observe that the section is predicated upon the assumption therein stated that the United States, in compliance with its obligation to the Buffalo Bayou Ship Channel Company, has constructed a ship channel through Galveston Bay from the Bolivar Channel to the channel constructed by the said Buffalo Bayou Ship Channel Company, known as Morgan Cut, for vessels of 12 feet draft.

It is understood by the Buffalo Bayou Ship Channel Company that the obligation of the United States in regard to the construction of such channel referred to in section cited is the acceptance by the United States by act of Congress of March 3, 1879 (20 Statutes at Large, page 367), of the proposition made by the Buffalo Bayou Ship Channel Company to the United States on the 12th of January, 1878, and embodied in the following resolution:

Resolved, That when the Government of the United States shall have completed a ship channel for vessels of 12 feet draft from Bolivar Channel to the channel constructed by this company, it will turn over and surrender to the United States Government the said work at cost or at the valuation that may be placed upon it by a commission of United States engineers designated by the Government of the United States to determine the value of the same.

We claim that the United States has never completed any such ship channel for vessels of 12 feet draft, and hold it can be easily demonstrated such channel does not and never has existed.

You will understand, of course, that I do not suppose you will consider it proper that we should enter into any discussion of our relative views in regard to the matters above referred to, but I merely wish to lay before you definitely and distinctly the position which the Buffalo Bayou Ship Channel Company feels compelled to take in respect thereto.

At substantially the same time with the making to the United States of the proposition referred to in the foregoing resolution, Captain Howell, of the U. S. Corps of Engineers, appraised the work done by the company at $179,658. Of course the action of this company was predicated upon the supposition and understanding that the ship channel for vessels of 12 feet draft referred to in this resolution was to be completed in a reasonable time after the passage of the resolution, and that the company should be reimbersed at least the amount of the value of the work as appraised by Captain Howell; but no such ship channel has been completed, even to the present day, as investigation in the War Department and the reports of the engineers and examination of the locality will plainly show.

The Ship Channel Company will, of course, gladly extend to yourself and the other engineers designated as constituting the commission every courtesy and facility which it is in its power to afford in connection with any investigation as to the character or value of the work which you may desire to make; but of course, it must be distinctly understood that the extension thereof is to be without prejudice to the rights of the company in respect to the matters above referred to and its claim as hereinbefore set forth.

Replying to your specific inquiry as to the present value, I can only say that the company has made no estimate whatever upon that subject, and of course without making a survey would be unable to give you any useful information in reference thereto.

The outlay of the company for the ship channel through Morgan Point and in Galveston Bay was about $500,000, including original outfit provided for the work, and, as has been already stated, the appraised value in 1877, at substantially the point of time of the proposition to the Governmene referred to in the act of 1879, was $179,658.

Recently a large outlay was made on a revetment in the channel through Morgan Point, which became necessary by the condition of the banks.

Very respectfully, your obedient servant.

E. W. CAVE,
President.

Lieut. WM. C. LANGFITT,
Corps of Engineers, U. S. A.,
Member Buffalo Bayou Ship Channel Commission.

Digitized by Google

H.—RESOLUTIONS OF THE BUFFALO BAYOU SHIP CHANNEL COMPANY.

Whereas, it is the desire of this company to facilitate the construction of a 12-foot ship channel through Galveston Bay by the Goverement of the United States, therefore,

Resolved, That when the Government of the United States shall have completed a ship channel for vessels of 12-feet draft from Bolivar Channel to the channel constructed by this company, it will turn over and surrender to the United States Government the said work at cost, or at the valuation that may be placed upon it by a commission of United States Engineers designated by the Government of the United States to determine the value of the same.

Resolved, That a copy of these resolutions, certified in due form under the seal of the company, be filed with the Secretary of War of the United States.

I, A. S. Richardson, Secretary of the Buffalo Bayou Ship Channel Company, do hereby certify the foregoing to be a true copy of resolution of the board of directors of said company, adopted January 12, A. D. 1878.

Witness my signature and the seal of said company at its office in the city of Houston, Tex., this 12th day of January, A. D. 1878.

[SEAL.] A. S. RICHARDSON,
Secretary.

Whereas, at a meeting of the board of directors of this company held this 12th day of January, 1878, the following preamble and resolutions were unanimously adopted, viz:

"Whereas, it is the desire of this company to facilitate the construction of a 12-foot ship channel through Galveston Bay by the Government of the United States; therefore,

"*Resolved*, That when the Government of the United States shall have completed a ship channel for vessels of 12 feet draught from Bolivar Channel to the channel constructed by this company it will turn over and surrender to the United States Government the said work at cost, or at the valuation that may be placed upon it by a commission of United States Engineers designated by the Government of the United States to determine the value of the same.

"*Resolved*, That a copy of these resolutions certified in due form under the seal of the company be filed with the Secretary of War of the United States."

Therefore resolved, That the action of said board of directors taken in said resolutions be, and the same is, approved and confirmed and adopted as the act of this company.

I, A. S. Richardson, secretary of the Buffalo Bayou Ship Channel Company, do hereby certify the foregoing to be a true copy of preamble and resolutions adopted unanimously at the regular annual meeting of the stockholders of said company held this day.

Witness my signature and the seal of said company at its office in the city of Houston, this 12th day of January, A. D. 1878.

[SEAL.] A. S. RICHARDSON,
Secretary.

I.—ACCEPTANCE BY BUFFALO BAYOU SHIP CHANNEL COMPANY OF PROVISIONS OF ACT OF MARCH 3, 1879.

Whereas, by an act of Congress approved March 3, 1879, the sum of $80,000 was appropriated for the improvement of the line surveyed from the cut in Red Fish Bar, to the cut in Morgan's Point in Galveston Bay, in the State of Texas, upon the proviso and condition as contained in said act, to wit:

"In consideration of the proposition of the Buffalo Bayou Ship Channel Company to turn over their work at Morgan's Point, and to surrender their charter granted by the legislature of Texas, and the rights accruing thereunder, to the United States, which proposition is now on file in the War Department, and is hereby accepted, the Government hereby adopts the line surveyed from the cut in Red Fish Bar to the cut in Morgan's Point, and the sum of eighty thousand dollars is hereby appropriated for the improvement of that line; *Provided*, That no part of said sum shall be expended until said Buffalo Bayou Ship Channel Company shall file with the Secretary of War, in manner and form to be by him approved, their acceptance of this provision of this act."

Now, therefore, we the undersigned, being all the individual members and stockholders of the said company, do hereby formally accept the said provision of said act; and do further, in consideration of said appropriation, covenant and agree that

Digitized by Google

upon the completion of the said improvement, we will enter into and subscribe to any and all such instrument or instruments as may be necessary or required in order fully to transfer and surrender to the United States the entire said work, together with the charter and rights aforesaid.

Witness our hands and seals this 22d day of January, A. D. 1881.

THE MORGAN'S LOUISIANA AND TEXAS RAILROAD AND STEAMSHIP COMPANY,
By CHAS. A. WHITNEY, *President.*

JNO. B. RICHARDSON, *Secretary.*	[SEAL.]
E. W. CAVE.	[SEAL.]
A. S. RICHARDSON.	[SEAL.]
JOHN SHEARN.	[SEAL.]
T. W. HOUSE.	[SEAL.]
J. R. MORRIS.	[SEAL.]
F. H. SCANLAN.	[SEAL.]
A. GROESBECK.	[SEAL.]
WIGGINS & SIMPSON.	[SEAL.]
CHAS. FORAKER.	[SEAL.]
W. B. BOTTS.	[SEAL.]
CHAS. A. WHITNEY.	[SEAL.]
A. C. HUTCHINSON.	[SEAL.]

I hereby certify that the names appended to the instrument of writing hereto attached comprise all the stockholders of the Buffalo Bayou Ship Channel Company owning paid-up stock in said company, and also the names of all those entitled to receive stock upon the payment of the balance due upon their subscriptions to stock, except the name of one subscriber for twenty shares of $100 each, and upon which subscription there has been paid in but one installment of 5 per cent. ($100).

I further certify that a copy of the said instrument of writing has been filed in the book of transfers of stock of said company.

Witness my signature as secretary of said company with the seal thereof affixed at the company's office in the city of Houston this February 14, 1881.

[SEAL.] A. S. RICHARDSON,
Secretary.

U 3.

IMPROVEMENT OF TRINITY RIVER, TEXAS.

The Trinity River empties into Galveston Bay through several mouths or passes near its northeast extremity, about 35 miles from Galveston. The relative importance of the passes appears to have varied considerably. The one generally used by vessels of late years is the Middle Pass. The channel depth in the river immediately above the passes is 16 feet or more. The depth in the Middle Pass is 9 feet or more. Opposite the mouth of each of the passes is a bar, the depth upon the crest of that of the Middle Pass being now 3 feet 6 inches. The trade using the river is carried in sailing vessels which draw from 3 feet to 4 feet 8 inches. To accommodate them there should be a channel 5½ feet to 6 feet deep.

It is stated upon page 539 of the Annual Report of the Chief of Engineers for 1871, that Pass A, or the Southeast Pass, was excavated by the Government in 1865 to facilitate the supply of fuel to the troops stationed in Galveston. This improvement was subsequently obliterated by natural causes. In 1880 a channel was dredged across the bar at the mouth of Middle Pass, its length being 4,800 feet, its average width 110 feet, and its least depth 5½ feet, the amount of material removed being 47,300 cubic yards. (See Annual Report Chief of Engineers 1881, page 1341.) This channel was also obliterated by natural causes. In the winter of 1884 and spring of 1885 a channel was again dredged through the bar at the mouth of Middle Pass to a least depth

Digitized by Google

of 6 feet, its length being 3,750 feet. A wooden revetment was placed upon the west side of the channel for a length of 2,775 feet, and upon the east side for a length of 1,280 feet, of which the object was to prevent the excavated material deposited near by from flowing back into the cut. The Annual Report for 1887 stated that the channel had shoaled in some places, that additional dredging was needed, and that the revetments required repairs and extension. The cost of the necessary work was estimated at $25,000.

An appropriation of $12,500 for continuing the improvement having been made in the river and harbor act of August 11, 1888, a survey was undertaken in April following to ascertain the condition of the bar and of the work executed for its improvement in 1884–'85.

The condition of the old works and bar, as found from that survey, is stated as follows in the Annual Report for 1889:

> The channel, though not obliterated, has shoaled considerably, and had a least depth at one point of only 3 feet 2 inches. The west revetment is in fair condition for a length of 1,800 feet from its upstream end; the remaining 975 feet being much damaged. The east revetment is in good condition for a length of 300 feet from its downstream end; of the remainder only the piles remain. Evidence of the action of the toredo is found at the downstream end of the west revetment, but for most of the distance the wood appears to have been protected by the presence of fresh water.

From the results of the survey it appeared best to construct two parallel jetties of timber, to extend from the mouth of the middle pass across the bar and into 6 feet depth of water in Galveston Bay, and to close, by means of submerged dams or sills, the other principal passes. The jetties to be placed about 275 feet apart and to have a total length of 15,350 feet; the length of the west jetty to be 7,750 feet, and that of the east jetty 7,600 feet; as much of the old work as was serviceable to be embodied in the west jetty.

The total cost of the foregoing, including removal of so much of the east revetment as might remain after completion of the work, was placed at $55,000. This plan and estimate was approved in 1889. Adding to the foregoing sum the amounts expended for dredging, etc., under former appropriations the revised estimated cost of the improvement is brought up to $89,500.

Under the appropriation made by act of August 11, 1888, 3,269 linear feet of west jetty were built. The result of the work, as stated in my last annual report, was a slight deepening in the channel running parallel with the line of new jetty, an increase in depth on the bar of about 4 inches, and a straightening of the channel, making the crossing of the bar easier than it was before the improvement commenced in 1889.

Congress, by act approved September 19, 1890, appropriated $10,000 for continuing the improvement. This sum was applied to construction of 1,360½ linear feet of west revetment, sufficient to join on to the old revetment, and to repairs of such portions of the old revetment as might be utilized in the work, and to contingencies.

The repairs were made by hired labor. The construction of 1,360½ feet was by contract entered into with J. J. Atkinson, of Houston. (See abstract of proposals herewith.)

The contract closed June 30. One thousand one hundred and seventy-six linear feet of the old revetment (constructed in 1884 and 1885) were repaired, though the repairs are not entirely completed, and the heads of the guide piles in the work constructed in 1889 and 1890 were protected.

The depth on the bar has remained practically the same as it was last year.

Digitized by Google

It is proposed with funds in hand to repair several hundred feet more of the old revetment, which will probably prolong its life for several years. The amount required to complete the work is $32,500, which can be profitably expended during the fiscal year ending June 30, 1893. For an account in detail of the work performed reference is made to the report herewith of Mr. Gerald Bagnall, assistant engineer.

A special agent was employed during the year to keep a record of the commerce and tonnage of the river. Statistics compiled from his reports are herewith. It appears from the comparative statement of statistics that the shipment of freight during the past fiscal year is slightly less than that for the preceding year.

Amount expended to July 1, 1890	$46,955.57
Amount expended during the past fiscal year	5,866.64
Total expended to July 1, 1891	52,822.21

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING TRINITY RIVER, TEXAS.

By act approved—	
June 18, 1878	$10,000
March 3, 1879	2,500
June 14, 1880	4,000
March 3, 1881	10,000
By act passed August 2, 1882	8,000
By act passed August 11, 1888	12,500
By act approved September 19, 1890	10,000
Total	57,000

Of this amount the sum of $7,500 was expended in 1882 in removing obstructions between Liberty and mouth of the river.

The sum of $32,500 can be profitably expended during the fiscal year ending June 30, 1893, in completing the work.

The work is located in the collection district of Galveston. The nearest lighthouse is at Red Fish Bar.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1891, was $174,489.92.

Money statement.

July 1, 1890, balance unexpended	$44.43
Amount appropriated by act approved September 19, 1890	10,000.00
	10,044.43
June 30, 1891, amount expended during fiscal year	5,866.64
July 1, 1891, balance unexpended	4,177.79
July 1, 1891, outstanding liabilities	223.48
July 1, 1891, balance available	3,954.31
Amount (estimated) required for completion of existing project	32,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1893	32,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Digitized by Google

Abstract of proposals for improving Trinity River, Texas, by constructing a timber jetty, received in response to advertisement dated January 26, 1891, and opened February 25, 1891, by Major Charles J. Allen, Corps of Engineers, at Galveston, Texas.

[Work: To constuct 1,250 feet more or less of timber jetty.]

No.	Name and address of bidder.	Price per linear foot.	Amount.
1	William Z. Partello, Washington, D. C	$3.96	$4,975.00
2	John Hogan, Mobile, Ala	3 74	4,675.00
3	John J. Atkinson, Houston, Tex	2.90	3,625.00
4	John C. Underwood, Columbia, Tex	4.60	5,750.00
5	James Moore, Galveston, Tex	2.93	3,662.50
6	John A. Cotter, Galveston, Tex	3.85	4,812.50

No. 3 lowest. Acceptance recommended. Amount available, $5,000 of the $10,000 appropriated by act of Congress of September 19, 1890.

REPORT OF MR. GERALD BAGNALL, ASSISTANT ENGINEER.

GALVESTON, TEX., *July 2, 1891.*

SIR: I have the honor to submit the following report of operations during the fiscal year ending June 30, 1891, for improving Trinity River, Texas.

A contract dated March 10, 1891, was entered into with John J. Atkinson, of Houston. The work was to begin not later than the 15th of April, 1891, and was to be completed on or before July 15, 1891.

On the 25th of April, the contractor having made all preparations, the actual work of construction commenced, and the subinspector took up his abode there. On May 1 the schooner *Mathilda* was chartered to be used as quarters for the assistant engineer, subinspector, and men employed on the repairs of the old portion of the jetty.

The work to be done by contract consisted of 1,250 feet more or less of timber jetty, closing the gap between the work of 1885 and 1890. One hundred and four feet was added to the length originally intended, as it was found necessary to pull up that much at the inner end of the work of 1884–'85, it being in such bad condition that it was impossible to make a good connection between the two works. The removal of this part of the old work was done by hired labor, the contractor kindly allowing the use of his plant.

The form of construction was the same as that used in the work of 1890, except that the guide-piles were to be cut off at 5½ feet above mean low tide instead of at 4 feet, and that bolts of seven-eighths-inch iron were used instead of bolts of 1-inch iron. The increase in height of the guide-piles was adopted, as it was found on examination of the old work of 1884–'85 that the guide-piles were in a state of fairly good preservation for a considerable distance out, except at their heads, which were rotted down to the upper stringers.

The work progressed only fairly well, as the machinery was constantly breaking down, and the contract was not completed until June 30, 1891. The contractor's plant consisted of two steam pile-drivers, two barges for material, one boarding boat, and one small flat.

During the progress of the contract work, repairs on the work of 1884–'85 were made by hired labor; this work for a distance of about 1,300 feet from the inner end was in fairly good condition, and only needed new stringers to make it serviceable. For a distance of 1,176 feet two new top stringers were bolted on immediately under the old ones, and over a part of this distance the old bottom stringers were either replaced by new ones or fastened with new bolts. The heads of the guide piles of the work of 1890 were protected by receiving two coats of tar; this work being also done by hired labor.

The summary of work done during the year is as follows: 1,360½ feet of timber jetty constructed by contract; repairs on 1,176 feet of timber jetty constructed in 1884–'85, about three-fourths done by hire labor; the heads of the guide piles of the jetty constructed in 1890, protected by hired labor.

The depth on the bar has remained practically the same as last year.

Digitized by Google

Accompanying this report is a sketch* showing the work constructed during the year.

Very respectfully, your obedient servant,

GERALD BAGNALL,
Assistant Engineer.

Maj. CHARLES J. ALLEN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF TRINITY RIVER, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

[Compiled from reports rendered by Special Agent T. A. Kilgore, of Wallisville, Tex.]

Sailing vessels using the river, 30; length on deck, 32 feet to 80 feet; draft when loaded, 2 feet 6 inches to 5 feet 6 inches; tonnage, 5 tons to 80 tons; trips made during the year, 1,115; total tonnage, 15,733.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton	38	$6,528	$149
Lumber	9,364	29,689	1,21[illegible]
General merchandise	552	10,817	2,22[illegible]
Total	9,954	47,034	13,58[illegible]

Decrease since last year, 1,773 tons.

Comparative statement of commercial statistics of Trinity River, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, and 1891.

Year.	Vessels using the river.	Maximum length.	Maximum draft.	Maximum tonnage.	Number of trips made.	Total tonnage.	Transported.				Total value of cargoes.	Total freight charges.
							Cotton.	Lumber.	General merchandise.	Total weight.		
		Feet.	*Ft. In.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	32	65	4 7	32	1,217	15,958	226	11,863	855	12,944	$88,704	$17,027
1889	36	65	4 5	32	1,330	16,737	148	10,872	1,159	12,179	75,902	17,276
1890	33	80	5 5	80	1,221	16,887	102	10,906	719	11,727	46,347	14,249
1891	30	80	5 5	80	1,115	15,733	38	9,364	552	9,954	47,034	13,582

U 4.

IMPROVEMENT OF CEDAR BAYOU, TEXAS.

A survey of this locality with view to removal of the bar at the mouth of the bayou was made in 1889, in accordance with the requirements of sections 13 and 14 of the river and harbor act of Congress of August 11, 1888. The results were embodied in a report published in House Ex. Doc. 84, Fifty-first Congress, first session.

* Sketch not forwarded.

Digitized by Google

Congress, by act of September 19, 1890, appropriated as follows:

Improving Cedar Bayou, Texas, by removal of bar at the mouth of said bayou, where it empties into Galveston Bay; completing improvement, eighteen thousand one hundred and fifty dollars.

This sum was the estimated cost, in the report above referred to, of dredging a channel 100 feet wide to afford a depth of 5 feet at mean low tide, and of protecting the cut on each side from action of waves and currents by walls or revetment, which would serve also to maintain dredge spoil in place. The material for revetment that then seemed advisable, on account of cost, was timber, it appearing from statements made to this office that fresh water from the Bayou and San Jacinto River would temper the salt water sufficiently at the mouth of the bayou, excepting during severe drought, to reduce the activity of the teredo, and to thus make it probable that timber revetment could be relied upon to last for a number of years at that locality. In December last, however, I made a personal examination of the locality, going up the bayou for about 3 miles. I found the bayou water for that distance full as salty as was the water of Galveston Bay. This fact induced me to recommend that the walls be built of brush and stone instead of timber, incorporating with the material a considerable portion of dredge spoil. Brush under such circumstances is expected to resist action of the teredo much better than unprotected timber would.

The cost of brush and stone walls or revetment will exceed by about $9,000 that of timber revetment estimated in the report of the survey of 1889. In that report the probable necessity of occasional redredging was stated in the following words:

Some additional dredging may occasionally be required at the entrance to and in the channel in order to maintain the depth.

For such dredging $5,000 should be available when needed.

The project for the improvement, approved May 12, 1891, provides for dredging to afford a depth of 5 feet at mean low tide; width of cut about 100 feet. And for revetment walls, jetties in fact, of brush and stone mattress, with more or less dredge spoil incorporated with the material, the jetties to rise 2 to 2½ feet above mean low tide.

Proposals for performance of work under the appropriation of September 19, 1890, were invited through public advertisement, dated June 25, and it is expected to begin the work in September next.

The cost of dredging, added to that required for completing the revetment, makes $14,000, the sum that can be advantageously appropriated for the fiscal year ending June 30, 1893.

The work is located in the collection district of Galveston. The nearest lighthouses are at Bolivar Point and Fort Point, at entrance to Galveston Bay.

The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1890, was $174,489.92.

Money statement.

Amount appropriated by act approved September 19, 1890	$18,150
July 1, 1891, balance unexpended	18,150
Amount (estimated) required for completion of existing project	14,000
Amount that can be profitably expended in fiscal year ending June 30, 1893	14,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Digitized by Google

COMMERCIAL STATISTICS OF CEDAR BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

[Compiled from information furnished by Mr. R. A. Milam, of Cedar Bayou, Tex.]

The freight is carried in 18 sailing vessels, with an aggregate tonnage of 483 tons, their average draft, loaded, being about 3½ feet.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Brick	17,500	$63,000	$12,250
Cotton	50	9,000	280
General merchandise	1,700	36,250	6,162
Total	19,250	108,250	18,612

U 5.

IMPROVEMENT OF BUFFALO BAYOU, TEXAS.

A survey of Buffalo Bayou and Galveston Bay to Bolivar Channel, with a view to improvement, was made in the winter of 1870–'71, in accordance with the provisions of section 2 of the river and harbor act of Congress approved July 11, 1870. The report of this survey is published in the Annual Report of the Chief of Engineers for 1871.

An examination of the bayou from Simms Bayou to the mouth of White Oak Bayou at Houston was made in 1880 under section 2 of the river and harbor act approved June 14, 1880. The report upon this examination is published in the Annual Report of the Chief of Engineers for 1881.

It was estimated in this latter named report that the cost of an improvement to give a channel 100 feet wide and 12 feet deep between the points named, by dredging and removal of snags and other obstructions, and including some necessary revetment, would be $385,299.75. Following this report was an appropriation of $25,000 by act approved March 3, 1881, for "improving Buffalo Bayou, Texas, to secure a channel of 100 feet."

A project in accordance with the terms of the appropriation and in consonance with the report was submitted April 25, 1881, and the subsequent appropriations have been applied in general furtherance of that project.

Buffalo Bayou is a tide-water stream emptying into San Jacinto River about 25 miles below Houston, the San Jacinto emptying into Galveston Bay. White Oak and Simms Bayous are tributaries to Buffalo Bayou, the former entering it at Houston and the latter at a point about 11 miles below Houston.

The object of the improvement is to secure a channel 12 feet deep and 100 feet wide, those being the dimensions contemplated for channel improvement in Galveston Bay, the aim being to admit seagoing ships to Houston. These dimensions of channel exist naturally in Buffalo Bayou and the San Jacinto below Simms Bayou, though it is reported that a small bar exists in San Jacinto River near Morgan Canal.

Morgan Canal is the name given to a channel excavated by the Buffalo Bayou Ship Channel Company through Morgan Point, a peninsula at the mouth of San Jacinto River. In Galveston Bay, in prolongation

Digitized by Google

of the canal, is Morgan Cut, also executed by the same company, connecting it with the ship channel dredged in the bay by the United States.

It is between White Oak and Simms Bayous that improvement of Buffalo Bayon is almost entirely needed. The banks here are high and generally stable, though occasionally subject to landslides. The surface width is generally greater than 100 feet, though there are some exceptions to this rule. The depth in the middle of the channel is usually 9 feet or more at ordinary tides, but there are occasional shoals upon which as little as 5 or 6 feet are found, and, during northers, the water surface is sometimes lowered several feet. At some points navigation is obstructed by the sharpness of the bends. It is endangered, also, by sunken logs and stumps in the bed of the stream and by overhanging trees upon the banks.

The commerce of the bayou is important. It is mostly carried on by means of barges towed by tugs. The draft of the latter is 7 feet or less; that of the former, when fully loaded, about 5 feet.

Even if but partial improvement of the channel be made with the sums appropriated, so as to secure 9 or 10 feet of water at mean low tide, the resulting benefit will be not only immediate but great, and this benefit will be increased by easement of bends and removal of snags, trees, etc. When a 12-foot depth is maintained throughout from Bolivar Channel to Morgan Canal, and through the latter to San Jacinto River, the depth in Buffalo Bayou can be correspondingly increased as appropriations are made.

A new supply of sunken logs is found annually in Buffalo Bayou, and considerable shoaling from surface wash also occurs annually.

Judging from the original estimate of cost of the improvement, the sum already expended, and the annual contributions of snags, logs, and silt to the stream, it is reasonably certain that the amount estimated for completion of the project, which has accompanied the annual reports upon the work, will not be sufficient for that purpose. To make a new estimate would involve a resurvey which would cost $5,000, but that expenditure, in view of the importance of the improvement, would be well repaid. In the absence of more definite information, the estimate of cost of the work as originally rendered, and which was undoubtedly correct at the time it was made, is retained in this report. It is $385,299.75.

The appropriation of $25,000, made by act of Congress, August 11, 1888, was applied to dredging and to removal of stumps and logs from bed and banks, between White Oak Bayou and a point 6 miles below, as stated in the last annual report.

Congress by act of September 19, 1890, appropriated $25,000 for continuing the improvement, which sum is also applied to dredging and to removal of stumps, logs, and overhanging trees. This work (dredging, etc.) is in progress under contract with J. J. Atkinson, of Houston, Tex. (See abstract of proposals hereto appended.) The work under this contract began in March last, and should be completed by August 1st next.

During the fiscal year the following named quantities of material were removed, viz:

Material dredged under water	cubic yards..	26,200
Material removed from above water	do....	2,900
Logs removed	cubic feet..	2,900
Overhanging trees removed	do....	13,348
Time expended in removing stumps	hours..	351½

Digitized by Google

The material from above water was removed at bend No. 4, and that from under the water at bends 1, 2, and 3, and also at Constitution bend.

The snags and stumps were removed between Constitution Bend and bend No. 4, a distance of about 2¼ miles.

The work performed up to July 13, 1889, at which date the appropriation of 1888 was exhausted, had resulted in easing the sharpness of several bends, and in giving, for the portion of the bayou worked over between White Oak and Simms bayous, a ruling depth of 9½ feet for a width of channel of 40 to 80 feet.

Heavy freshets in the spring of 1890, however, caused shoaling in some parts of the bayou, notably in the vicinity of Houston, though not enough to materially affect navigation of the bayou by the class of vessels at present using it.

The work done during the fiscal year just ended has resulted in further easing the bends and in removal of a large number of obstructions from the bed and banks of the bayou.

It is expected to move the dredges next month to the immediate vicinity of Houston, in order to commence the work of removing the shoals already spoken of.

The value of the improvement of the bayou already effected by the Government is set forth in the letter, hereto appended, of H. W. Garrow, president of the Houston Cotton Exchange and Board of Trade. Assistant Engineer R. B. Talfer was in supervision of the work, under my direction, throughout the period embraced by the contract. His report of operations is herewith.

The trade of the bayou is principally carried on by the Houston Direct Navigation Company with tugs and barges. A statement of the freight carried by them during the past fiscal year is appended. Many small vessels also visit the bayou. To ascertain the extent of this trade a special agent was employed throughout the year to keep a daily record of all such vessels. The shipments of cotton down the bayou from Houston to be loaded on to seagoing vessels at Galveston are immense. The number of tons thus shipped during the past fiscal year was 81,548 as against 66,852 for the year preceding.

While the appropriations thus far made from time to time for this improvement have aggregated but about 44 per cent. of the originally estimated cost of the improvement, and while the work done under those appropriations has, in consequence, not secured the full depth or width of the channel required, the improvements thus far effected have so greatly facilitated navigation that further and regular appropriations for the improvement of this important stream can justly be asked for. In view of the probable increase in the commerce of Buffalo Bayou, some of those interested in its navigation favor an improved channel of greater dimensions than the present project provides for. The practicability and cost of such increased channel can only be decided by a full and complete survey.

Aggregate amount appropriated to July 1, 1891	$168,750.00
Expended under the project to July 1, 1890	143,691.73
Expended during the past fiscal year	12,008.63
Total expended under the project	155,700.36

The balance of the funds available will be applied to continuance of work under the present contract and to contingent expenses.

It is estimated that the sum of $50,000 can be profitably expended

Digitized by Google

during the fiscal year ending June 30, 1893, in continuing the improvement by again going over the ground more or less where dredging has been done; in widening the water way where the surface width is less than 100 feet and where the cost of widening is not excessive and where the banks will bear such widening without danger of sliding; in deepening the channel where its depth is less than 10 feet; in easing the bends, and in removal of logs, stumps, etc.

The work is located in the collection district of Galveston. The nearest lighthouses are those in Galveston Bay. The amount of revenue collected at the port of Galveston for the fiscal year ending June 30, 1891, is $174,489.92.

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING BUFFALO BAYOU, TEXAS.

By act approved March 3, 1881	$25,000
By act passed August 2, 1882	50,000
By act approved July 5, 1884	25,000
By act approved August 5, 1886	18,750
By act of August 11, 1888	25,000
By act approved September 19, 1890	25,000
Total	168,750

Money statement.

July 1, 1890, balance unexpended	$58.27
Amount appropriated by act approved September 19, 1890	25,000.00
	25,058.27
June 30, 1891, amount expended during fiscal year	12,008.63
July 1, 1891, balance unexpended	13,049.64
July 1, 1891, amount covered by uncompleted contracts	9,141.93
July 1, 1891, balance available	3,907.71
Amount (estimated) required for completion of existing project	216,549.75
Amount that can be profitably expended in fiscal year ending June 30, 1893	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for improving Buffalo Bayou, Texas, received in response to advertisement dated January 5, 1891, and opened February 2, 1891, at Galveston, Tex., by Maj. Charles J. Allen, Corps of Engineers.

No.	Name and address of bidder.	Character of work.	Price.	Amount.
			Cents.	
1	John J. Atkinson, Houston, Tex.	Dredging material under water, 59,000 cubic yards, per yard	30	$17,700
		Dredging and scraping material above water, 13,000 cubic yards, per yard	25	3,250
		Removing sunken logs, 1,000 cubic feet, per foot	6	60
		Removing overhanging and dead trees, 2,000 cubic feet, per foot	5	100
		Removing stumps and wrecks as may be necessary, per cent. above actual cost	10	.....
		Total	.....	21,110

Only one bid received. Acceptance recommended.
Amount available, $25,000 (less office and inspection expenses.)
Appropriated by act of September 19, 1890.

Digitized by Google

REPORT OF MR. R. B. TALFOR, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Houston, Tex., June 30, 1891.

SIR: I have the honor to submit the following report relating to the improvement of Buffalo Bayou, Texas, for the current fiscal year ending June 30, 1891.

1. The work of improvement began March 10, under a contract with Capt. J. J. Atkinson, superintendent of the Houston Direct Navigation Company, who with a plant (No. 1), consisting of 1 Osgood dredge and 1 derrick, commenced operations by cutting off the point at Bend No. 3. The material excavated by this dredge and rehandled by this derrick, which has a boom 86 feet long, was carried from the dredge's dipper and deposited on the bank about 90 feet from the water's edge. An extra plant similar to No. 1 was put to work May 5, and the removal of this point was finished May 19, since which time both plants have been steadily at work and have removed the shoal points at Bends Nos. 1 and 2, also at Constitution Bend, besides taking out a large number of the worst snags and stumps that interfered with the present improved navigation between Constitution Bend and Bend No. 4, a distance of 2¼ miles.

2. Removing the overhanging trees that interfered with navigation, more especially during a high stage of water. The portion of the banks cleared lies between Constitution Bend and a point about three-quarters of a mile above Kounslar's House, about 3 miles in all. (See tracing). There still remain a large number of trees to be removed between this point and Houston.

3. Removing by mule teams and scrapers a deposit of from 3 to 5 feet in depth that had taken place over the point at Bend No. 4, this point having already been scraped in 1889, the area under water not having been dredged at that time, owing to the appropriation being exhausted. This deposit was caused by several floods between 1889 and 1891, coming from the Upper White Oak and Buffalo Bayou regions, whose banks are badly broken and easily eroded, especially those of White Oak Bayou. It is expected that the work at this point (Bend No. 4) will probably be completed by July 31, 1891. The plants will then be moved to the turning point (junction of the White Oak and Buffalo bayous), foot of Main street, Houston, and will remove the deposit that has taken place since 1889.

In connection with the above I would respectfully refer to the report of the Chief of Engineers, part 3, page 1562, 1889, viz: * * * "Planting of Bermuda grass on the banks above the turning point, also putting in covered drains (with catch basins) at the mouths of the artificial and natural drains to prevent the shoaling that takes place at these points after heavy rains. This part of the work (wooden drains) has been done in two instances by the contractor, Captain Atkinson, at his own expense, notably at the foot of La Branche street, Houston, in 1883, and again under the present contract at Bend No. 4, where the conformation of the ground back from the bayou is such that the material dredged from the point is liable to be again carried into the bayou by heavy rains."

In the interim (since 1889) there has been considerable public improvement going on in the city of Houston, viz., paving of streets and sewerage. The latter I would respectfully draw your attention to, as it must ultimately affect the regimen of the bayou from Houston towards Harrisburg, a distance of 9 miles by water.

I am indebted to Mr. Charles W. Lewis, city engineer, for the following statement regarding the public sewers now being constructed, and areas drained by said sewers:

REPORT OF MR. CHARLES W. LEWIS.

Thirty-nine by fifty-one inch brick combined sewer emptying into bayou at foot of Congress street. This sewer is intended to drain surface water besides sewage and covers an area of about 100 acres; 5 miles of pipe laid.

Twenty-four inch vitrified clay pipe emptying into bayou at foot of La Branch street, for house sewage only, and covers an area of about 250 acres; 12 miles of pipe laid.

Four by five and one-half foot brick drain, emptying into bayou at foot of Caroline street. This is a combined sewer draining about 100 acres; 2¾ miles of pipe laid.

There is comparatively a small number of house connections made with these sewers, and the volume of sewage at present is limited.

The city of Houston intends, as soon as the demand requires, to lay a large pipe or conduit to take the sewage from the various sewers and discharge at some point about 2½ to 3 miles south of the center of the city.

Besides the sewers enumerated as above, it is contemplated to lay sanitary sewers throughout the entire city as soon as the population requires the same.

There are also two private lines of sewers discharging into the bayou at the foot of Fannin street and Prairie street, respectively. These two sewers drain a very small area; they will ultimately be connected with the public sewers.

Digitized by Google

In conclusion, I would respectfully suggest that, before any further appropriation be expended, a careful survey be made of the bayou from White Oak to Sims Bayou, showing cross sections of the bed and banks for a distance of not less than 150 feet from the water's edge at each side, and also that the nature of the underlying strata be determined by borings.

Amount of work done under the present appropriation, from March 10 to June 30, 1891 (end of fiscal year):

Material (under water) dredged	cubic yards	26,200
Material (above water) scraped	do	2,900
Logs removed	cubic feet	2,900
Time expended in removing stumps	hours	351½
Overhanging trees removed	cubic feet	13,348

Very respectfully,

R. B. TALFOR,
U. S. Assistant Engineer.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

LETTER FROM H. W. GARROW, ESQ., PRESIDENT HOUSTON COTTON EXCHANGE AND BOARD OF TRADE.

HOUSTON COTTON EXCHANGE AND BOARD OF TRADE,
Houston, Tex., June 18, 1891.

DEAR SIR: It affords me pleasure to write to you, noting the improvement that has taken place in our bayou, through the work done under the Government appropriations.

Prior to the season of 1880-'81, the navigation of the bayou by the barges engaged in the carrying trade was often seriously interrupted by *northers*, which, blowing the water out of Galveston Bay, lowered the water in the bayou to such an extent that the barges grounded on the shoal places, and were detained 1, 2 and, sometimes 3 days. These conditions have been improved on since the commencement of the work by the Government, and the improvement has continued each year till now, when the work done by the Engineer Department of the Government has resulted in giving us a channel of at least 8½ feet depth from Houston to the deep water of San Jacinto River, whereas before the Government took hold we did not have at extreme low water more than 3½ feet on the numerous shoals between this city and Clinton, 11½ miles.

In addition to this, we beg to inform you that the time between here and Clinton (11½ miles), where most of the work has been done, has been shortened quite three-quarters of an hour, and the tugs engaged in the trade are able to carry a larger tow, and larger barges have been built. This improved condition has resulted in reducing the freight charges from 75 cents a bale to 50 cents a bale.

The amount of cotton carried this season is over 290,000 bales, so you will see that the saving to commerce this year on this one article is over $72,000. Besides the cotton there has been 10,000 tons of miscellaneous freight, such as cotton seed, meal, and cake; coal, lumber, etc.

When we take into consideration that this has been accomplished under small and irregular appropriations, we can but feel gratified; and it must be a source of gratification to you, and the officers who have preceded you, to know that the money has been judiciously expended and where it would do the most good, and we can but feel that our Congress, noticing that the money which has been spent has resulted in so much good, will be disposed to place a larger sum at the disposal of the Engineer Department.

With the improvement of the ship channel in Galveston Bay and the removal of the tolls at Morgan Point, and with larger appropriations for this very important work, the commerce of Buffalo Bayou will be doubled. In fact, I am of the opinion that in the next few years a carrying capacity for 500,000 bales of cotton will be required.

I can not close this letter without expressing to you our high appreciation of the care and attention which has been given to this work by you and your predecessors, and to your able assistant, Capt. R. B. Talfor, who has had immediate supervision under orders of Engineer officers in charge.

Yours,

H. W. GARROW,
President Houston Cotton Exchange and Board of Trade.

Maj. C. J. ALLEN.

Digitized by Google

COMMERCIAL STATISTICS OF BUFFALO BAYOU, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

[Compiled from reports of special agents L. F. Allien, of Houston, Tex., and L. Meggett, secretary of the Houston Direct Navigation Company.]

Number and character of vessels using the bayou.—Thirty-one barges, 65 feet to 162 feet long, 4 feet to 6 feet draft; tonnage, 23 to 358 tons. Four steam tugs, 50 feet to 94 feet long, 4 feet to 6 feet draft; tonnage, 12 tons to 105 tons each. Thirty-three schooners and sloops, 30 feet to 80 feet long, 2 feet to 5 feet draft; tonnage, 4 tons to 40 tons each. Trips made during the year, 2,274. Total tonnage, 295,869 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Cotton (297,592 bales)	81,548	$15,908,535	$127,903
Cotton seed, cake, and meal	12,469	234,017	11,074
Coal and wood	9,810	39,807	7,291
Lumber and shingles	622	10,547	1,740
General merchandise	3,639	49,889	8,898
Total	108,088	16,243,395	156,906

Increase since last year, 11,854 tons.

Comparative statement of commercial statistics of Buffalo Bayou, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, and 1891.

Years.	Vessels using bayou.			Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	Schooners.	Tugboats.	Barges.					
	No.	*No.*	*No.*	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	62	7	20	173	8	254	920	.....
1889	38	7	19	173	7	254	735	.....
1890	42	7	19	173	7	254	617	.....
1891	33	4	31	162	6	358	*2,274	*295,869

Years.	Transported.						Total weight.	Total value.	Total freight charges.
	Cotton.	Cotton-seed cake.	Coal and wood.	Lumber and shingles.	Iron and steel.	General merchandise.			
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*		
1888	26,692	9,959	4,320	2,765	1,509	4,596	49,841	$5,132,323	$94,960
1889	41,227	12,628	3,456	1,221	1,120	898	60,550	7,017,380	98,794
1890	66,852	19,199	2,970	512	1,278	5,423	96,234	13,880,766	154,715
1891	81,548	12,469	9,810	622	.....	3,639	108,088	16,243,395	156,906

* First year of complete reports.

U 6.

IMPROVEMENT OF HARBOR AT BRAZOS SANTIAGO, TEXAS.

The work of construction for improvement of this harbor was suspended in October, 1884. The subject of improvement of the harbor was referred by the Chief of Engineers, under date of December 8, 1885, to the Board of Engineers for report. The Board called for certain information which involved a resurvey of the harbor and other investigations. A surveying party left Galveston on the 24th of June,

Digitized by Google

1887, to procure the desired information, completing the survey early in August following. The results of the survey were reported under date of September 29, 1887. The report showed that the work (south jetty) completed in 1884 had practically disappeared. The project under which that jetty had been built contemplated the construction of two parallel jetties, as follows: The south jetty (Brazos Island Jetty) to be 3,630 feet long and the north jetty (Padre Island Jetty) to be 2,940 feet; the direction of the jetties to be in prolongation of the pass, the width between them to be about the same as that of the narrowest part of the pass, viz, 1,500 feet; estimated cost of the north jetty about $130,000; estimated cost of the south jetty about $190,000. In addition it had been proposed to construct a dam from Point Isabel to Brazos Island to increase the depth of water on the bar and the channel to Point Isabel by preventing the flow towards Boca Chica. Approval had been given to so much of the project as covered the construction of the south jetty. For information in detail as to the condition of the work and cost of further improvement reference is here made to the report of September 29, 1887, and to that of the Board of Engineers, both contained in Appendix T to the Annual Report of the Chief of Engineers for 1888, pages 1322–1330 and pages 1299 and 1300.

From the best information attained by the survey the cost of an improvement to consist of two parallel jetties placed about 1,100 feet apart was estimated at not less than $1,130,000, and it was also estimated, in the Annual Report for 1888, that the appropriation necessary for carrying on that work (should it be ordered) for the fiscal year ending June 30, 1890, should not be less than $600,000. The total of expenditures under appropriations at the date of rendering the estimate of $1,130,000 was $188,590.23, so that the revised estimate of cost of the improvement, counting from the commencement of the work, was thus brought up to $1,318,590.23.

The total of appropriations to include the last one, that of $25,000, by act of August 11, 1888, is $247,500. The expenditures since work ceased in 1884 have amounted to $4,944.87 in making survey and in contingencies included in the latter the cost of collecting commercial statistics of the port.

No work for improvement was done during the past fiscal year, the amount of money available having been too small to warrant commencing it. A special agent was employed during the year to keep a daily record of all incoming and outgoing trade. Commercial statistics compiled from this record are hereto appended. It will be seen that the trade of the port is comparatively light. Comparison of this with records of last year shows a decrease of tonnage of 371 tons.

The conclusion that not less than $600,000 should be available before undertaking further work is here concurred in, though it is not asserted that the amount of commerce to be benefited justifies such an expenditure at this time. And it is respectfully suggested that if the importance of the port to be considered sufficient to justify so large an appropriation the improvement be deferred for the present. There remain in round numbers $540,000 as the sum that should be appropriated for the fiscal year ending June 30, 1893, in case Congress orders the improvement indicated.

Original estimated cost of the work as revised in 1888, $1,318,590.22; aggregate amount appropriated to July 1, 1891, $247,500; amount expended to July 1, 1890, $189,318.59; amount expended during the past fiscal year, $290; total expended to July 1, 1891, $189,608.59.

Digitized by Google

In addition there was appropriated in 1878 $6,000, which was applied to removing a wreck.

The work is located in the collection district of Brownsville. The nearest light-house is the Brazos Santiago light-house on Padre Island. The amount of revenue collected at the port of Brownsville during the fiscal year ending June 30, 1891, was $8,386.32.

ABSTRACT OF APPROPRIATIONS MADE BY CONGRESS FOR IMPROVING HARBOR AT BRAZOS SANTIAGO, TEXAS.

By act approved—	
June 14, 1880	$25,000
March 3, 1881	75,000
By act passed August 2, 1882	60,000
By act approved—	
July 5, 1884	25,000
August 5, 1886	37,500
By act of August 11, 1888	25,000
Total	247,500

Money statement.

July 1, 1890, balance unexpended	$58,181.41
June 30, 1891, amount expended during the fiscal year	290.00
July 1, 1891, balance unexpended	57,891.41
Amount (estimated) required for completion of existing project	1,071,090.23
Amount that can be profitably expended in fiscal year ending June 30, 1893	540,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS OF BRAZOS SANTIAGO, TEXAS, FOR THE FISCAL YEAR ENDING JUNE 30, 1891.

[Compiled from reports rendered by special agent E. J. Kenedy, of Isabel, Tex.]

Vessels using the harbor, 20; character, 4 steamers and 16 sailing vessels. Length on deck, 44 to 220 feet; draft, 4 feet 6 inches to 10 feet 6 inches. Tonnage, 11 to 717 tons. Trips made during the year, 120; total tonnage, 44,536 tons.

Amount and value of freight transported.

Articles.	Tons.	Approximate value.	Approximate freight charges.
Wool and hides	3,218	$171,035	$18,569
Lumber	2,434	30,813	11,071
General merchandise	15,992	859,234	130,575
Total	21,644	1,061,082	160,215

Decrease since last year, 371 tons.

Digitized by Google

Comparative statement of commercial statistics of Brazos Santiago Harbor, Texas, for the fiscal years ending June 30, 1888, 1889, 1890, and 1891.

Year.	Vessels using harbor.	Maximum length.	Maximum draft.	Maximum tonnage.	Trips made.	Total tonnage.
	No.	*Feet.*	*Feet.*	*Tons.*	*No.*	*Tons.*
1888	12	241	10	678	126	44,741
1889	14	241	10	678	158	46,319
1890	20	219	9	717	170	40,641
1891	20	220	10.5	717	120	44,536

Year.	Transported.					Total value.	Total freight charges.	Revenue collected.
	Cotton.	Wool and hides.	Lumber.	General merchandise.	Total weight.			
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*			
1888		2,925	2,324	9,867	15,116	$737,432	$83,541	$31,625.00
1889	130	3,080	3,188	10,885	17,283	820,315	78,140	20,338.00
1890	80	4,153	2,938	14,844	22,015	1,069,189	129,132	37,990.00
1891		3,218	2,434	15,992	21,644	1,061,082	160,215	8,386.32

U 7.

PRELIMINARY EXAMINATION OF MOUTH OF DOUBLE BAYOU, CHAMBERS COUNTY, TEXAS, TO REMOVE OBSTRUCTIONS.

[Printed in House Ex. Doc. No. 117, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 22, 1890.

SIR: I have the honor to submit herewith the accompanying copy of report, dated December 10, 1890, from Maj. C. J. Allen, Corps of Engineers, giving results of preliminary examination for "survey to remove obstructions at mouth of Double Bayou, in Chambers County," Tex., made to comply with provisions of the river and harbor act of September 19, 1890.

Major Allen reports that, taking into consideration the disproportion between the cost of an improvement and the probable total saving in freight charges per annum, he feels constrained to regard this locality as not coming under the head of those that should be improved by the General Government at this time. For the reasons stated by Major Allen, Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, reports that he does not think Double Bayou now worthy of improvement. I concur in the views of these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 10, 1890.

GENERAL: I have the honor to submit the following report of a preliminary examination of Double Bayou, Chambers County, Tex., made in compliance with the requirements of sections 17 and 18 of the river and harbor act of Congress approved September 19, 1890.

Digitized by Google

An examination of the locality was made under my direction in November last by Lieut. William C. Langfitt, Corps of Engineers, a copy of whose report is herewith.

It is seen from that report that Double Bayou, which empties into Galveston Bay from its eastern shore at a point about 30 miles distant from Galveston, has a length of about one-half a mile from its mouth to the forks of two narrower bayous tributary to it. The width of the main bayou is about 180 feet at its mouth and 130 feet near the forks, and its low-water depth is from 5½ to 10 feet. The two narrower or tributary bayous have widths, respectively, of 130 feet and 100 feet near the junction or forks, the widths decreasing, respectively, to about 50 and 35 feet at distances of 10 miles from the forks, the ruling depths in each being at low water about 5 feet.

The present commerce of the bayou and its tributaries is carried on in about 23 small vessels of 2½ to 3 feet draft, the annual value of the commerce being given at about $80,000, on which the freight charges amount to about $8,000.

The obstruction to navigation at the mouth of the bayou consists of a shoal about one-half mile across, upon which the ruling depth in the channel at mean low tide is 2.4 feet.

It is claimed by those interested in the commerce and navigation of Double Bayou that an improvement of the bar permitting a 4-foot draft at mean low tide would reduce freight rates by 10 to 50 per cent.; that it would save perishable produce from being spoiled through detention on the bar, and also be followed by a growth in the trade and settlement of the country and an increase in the commerce and navigation of the bayou.

It is possible that the first cost of such an improvement at this point might be reimbursed to the public within six or seven years by the saving in freight charges due to an improvement, supposing the saving to average 30 per cent. of the present rates.

Whether Double Bayou should be improved by the General Government may admit of some discussion, but taking into consideration the disproportion between the cost of an improvement and the probable total saving in freight charges per annum, I feel constrained to regard it as not coming under the head of localities that should be improved by the General Government at this time.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 18, 1890.

Respectfully forwarded to the Chief of Engineers.

For the reasons stated by the district officer, I do not think Double Bayou, Tex., now worthy of improvement.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Digitized by Google

REPORT OF LIEUT. WM. C. LANGFITT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., November 29, 1890.

MAJOR: I have the honor to submit the following report on the preliminary examination of Double Bayou, Chambers County, Tex., made November 24–25, 1890, in accordance with your verbal instructions.

I made such examination of the bar at the mouth of the bayou and of the streams themselves as was possible; visited the head waters and interviewed several of the prominent citizens interested in obtaining the improvement, and gathered such information as was possible that would enable you to form an idea as to the requirements of the case.

Double Bayou enters Galveston Bay about 30 miles from Galveston, on the eastern shore of upper bay. At a distance of about one-half a mile from its mouth the bayou divides into two branches, from which fact the name is properly derived. The northern branch is known as the North Branch or Anahuac Bayou; the other as the South Branch. The main stream is about 180 feet wide near the mouth, which is reduced to 130 feet near the forks. The North Branch is about 130 feet wide near the junction, while the South Branch is about 100 feet wide. Navigation extends on the North Branch about 14 miles, and on the South Branch about 10 miles from the mouth of the main stream. The banks of all three are quite steep, and range from 4 feet above mean low tide at the mouth of the main stream to 10 or 12 feet at the head waters of the two branches. The North Branch decreases in width from the junction, and at a point about 10 miles up where I crossed, it is about 50 feet wide, navigation being possible, I was told, for a distance of 4 miles farther. The South Branch decreases in width from the junction and at a point about 10 miles up is about 35 feet wide. There is a bridge across the bayou at this point and is the head of navigation. The depth in the main stream varies gradually from 5.5 feet just inside the mouth to about 10 feet near the junction. In the North Branch the depth near the junction is about 6 feet, which can be carried almost to head of navigation. The South Branch is about 8 feet deep near junction, which decreases to about 5 or 6 feet just below the bridge where I crossed it. In all three a 4-foot depth is found relatively quite close to the banks.

I am told that both branches have their sources in large marshes that extend many miles back into the country.

During times of no rain there is no current in the streams except that due to the tide, and after a very long drought the water becomes salt throughout their whole extent. The tidal fluctuation is about the same as that at Round Point, or, say, .65 foot as a mean of all tides. The tidal influence is felt, I was told, to the sources of the bayou. In times of heavy rains both branches rise as much as 10 or even 12 feet near their sources. The main or Double Bayou rises about 4 feet under the same circumstances. The channel used by the vessels turns southward after leaving the mouth of the bayou and then turns to westward, the shoalest depth being about 2.4 feet at mean low tide. The shoaling begins even inside the mouth, showing a long continuation of slack current.

The commerce of the bayou is carried on in small vessels, about 23 in number, ranging from 25 to 35 feet in length and from 3½ to 10 tons. Their load draft at present is 2½ to 3 feet.

The value of the commerce both in and out has been estimated by members of the community interested at $80,000 or over, about equally divided. The outgoing products consist of cotton, wood, charcoal, sirup, calves, and country produce, vegetables, etc. The incoming trade consists of general merchandise used as supplies for the people living on or near the bayous.

Freight charges are heavy, the following rates being obtained from several residents on the bayous, and are from the bayou to Galveston: Dry barrels, 25 cents; wet barrels, 35 cents; produce, 20 per cent. of selling price in Galveston; wood, 50 per cent. of selling price in Galveston; cotton, $1 per bale, or 20 cents per 100 pounds in seed. The freights from Galveston to the bayou are correspondingly high, for instance, being 20 cents on a sack of cotton-seed oil cake valued at from 90 cents to $1, but on many articles it would be much less. As an approximation the freight charges can be taken as 10 per cent. of the value of the commerce, or say $8,000.

The reasons advanced by those interested in the matter for the improvement of the bar at the mouth of the bayou are given briefly below.

(1) Reduction of freight rates by from 10 to 50 per cent.

(2) Saving of perishable produce from being spoiled no longer by detention at the bar, which in winter may amount to several days.

(3) That all the business (except the cattle trade) of the country bordering on the bayous is done on them and it is expected that any improvement of the bar would be followed by a growth in the trade and a more rapid settlement of the country. The nearest railroad station at present is 25 or 30 miles from the head waters of the

Digitized by Google

bayous, and on account of the peculiar position of the country there is practically no prospect of nearer railroad communication. It is stated that if the bar were improved to admit vessels capable of entering the cattle trade economically a large business in this line would immediately spring up. At present to ship cattle to market requires driving them 25 to 30 miles on foot, and shipment by rail of about 200 miles. At the same time it is expected that the wood, charcoal, and agricultural interests would be greatly benefited.

Generally speaking, however, I found that an improvement permitting 4 feet draft to be carried over the bar at mean low tide would satisfy the community.

Very respectfully, your obedient servant,

WM. C. LANGFITT,
First Lieutenant, Corps of Engineers.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

U 8.

PRELIMINARY EXAMINATION OF TRINITY RIVER, TEXAS, FROM ITS MOUTH TO DALLAS.

[Printed in House Ex. Doc. No. 275, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 20, 1891.

SIR: I have the honor to submit the accompanying copy of report dated January 26, 1891, from Maj. Charles J. Allen, Corps of Engineers, giving results of preliminary examination of Trinity River from its mouth to Dallas, Tex., made to comply with provisions of the river and harbor act approved September 19, 1890.

Major Allen reports that this river can not be regarded as worthy of improvement by the General Government, an opinion which Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division, also holds, and in which I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR CHAS. J. ALLEN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., January 26, 1891.

GENERAL: I have the honor to report as follows upon a preliminary examination of Trinity River from its mouth to Dallas, Tex., made in compliance with the requirements of sections 17 and 18 of the river and harbor act of Congress of September 19, 1890.

From Dallas to the mouth of the Trinity, where the river discharges into Galveston Bay at a point about 35 miles distant from the city of Galveston, the general course of the river is southeast. The distance by the channel is about 500 miles, while in a direct line it is about 240 miles, the difference being due to the windings of the stream.

At Dallas the low-water width is less than 100 feet, while at Wallisville, just above the mouth, the width increases to 500 feet. Between these points the widths vary. The river flows partly over rocky or gravelly bars and partly over bars of sand. The banks are largely

Digitized by Google

composed of light alluvion easily eroded by river currents and of the kind, where timbered, to contribute quantities of snags to the stream after every flood. The range between high and low water, excepting at or near the river mouth, is great, and, during floods, immense areas of bottom lands are overflowed. Portions of the river have been surveyed at different times with a view to improvement, the stream in the early history of Texas, and even later until the building of railroads, having been one of the most important avenues of commerce in the State.

The river and harbor act of Congress approved August 30, 1852, appropriated the sum of $3,000 for "the survey of Trinity River, Texas, including the bar at the mouth." It does not appear, however, that any appropriation for improvement followed this order for the survey.

The act of July 11, 1870, also provided for a survey at the mouth of the river. The report of this survey, made in 1871, contained an estimate for improving the mouth. The report referred to 9 steamboats making regular trips up the Trinity River during "the active season."

The act of June 10, 1872, contained provision for a survey of the river from its mouth to Magnolia, a distance of about 320 miles. In the report of that survey it is stated that, in 1870 and 1871, the number of boats (steamboats, presumably) engaged in the Trinity River trade was 14, and that in 1872 the number was 17; but that the shipment of cotton, which in 1870 amounted to 23,319 bales and in 1871 to 27,942 bales had, in 1872, reduced to 14,244 bales, and it was expected that the year 1873 would show a still greater decrease. The decrease was attributed mostly if not entirely to the completion of the International and Great Northern Railroad, which crosses the Trinity at Riverside. Cotton shippers preferred shipping by rail to waiting for favorable stages of the river to make shipment by boat. From the appendix to the same report I extract the following to show the general condition of 320 miles of the stream:

At low water the upper river (above Chalk Bluff) is from 50 to 100 feet in width and from 3 inches to 12 feet in depth. * * * It is made up of a succession of rocky or gravel shoals or rapids from 50 to 3,000 feet in length, between which are nearly stagnant portions, as well as deeper portions of the river, from one-quarter to 2 miles in length. * * * The lower river (from Chalk Bluff to the mouth, about 180 miles) gradually widens as it nears the mouth until, at Wallisville, its general width is 500 feet. The curves in the lower river are not as abrupt as those of the upper river, but they are very tortuous, and nearly every bend has more or less old timber in its bed. Instead of rocky or gravel shoals sand-bars occur at nearly every bend, with as little water over them as have the shoals of the upper river, between which are currentless portions of river.

The officer in charge summed up the situation as follows:

That portion of the river between the towns of Liberty and Magnolia is navigable only during the period of high water, during which time the steamers running to Magnolia find no difficulty in the navigation of the river; during the period of low water, however, navigation with vessels drawing over 6 inches of water is impossible, unless an expensive and unwarrantable system of locks and dams is adopted. No improvement of this portion of the river is required. The improvement of the river below Liberty would be of some benefit to the commerce of the region this portion of the river traverses.

The officer in charge rendered an estimate for improvement from Liberty to and including the river mouth.

The act of Congress, June 18, 1878, appropriated $10,000 for "deepening the channel at the mouth of the Trinity River, Texas, and removing obstructions to Liberty," which sum was applied to improvement so far as it would go.

The act of March 3, 1879, further appropriated $2,500 for improving the mouth of the river, and the same act provided for a resurvey of the river from its mouth to the bridge of the Great Northern Railroad.

Digitized by Google

The officer in charge reported upon the results of that survey as follows:

Above Liberty, the head of tide water, and 41 miles from its mouth [the river's mouth], no sufficient improvements can be made, except at a cost out of all proportion to the importance of the interests to be benefited, the river being a succession of rocky or gravel shoals, with deep pools between, very tortuous, with abrupt bends, and filled with snags, which become waterlogged and are not carried off during the high stage of the river. Below the character of the river changes entirely. Between Liberty and Moss Bluff it varies in width from 200 to 275 feet, and in depth from 5 to 30 feet, with the exception of a bar with 2 feet of water on it 4¼ miles below Liberty. From Moss Bluff to the mouth of the river it opens out to 500 feet in width, and a depth of from 10 to 45 feet free from any obstructions.

The act of Congress, June 14, 1880, appropriated $4,000 for improving Trinity River, which amount was applied to cutting through the sand bar below Liberty and in removing snags between that point and the mouth of the river.

Although the depth in the river for some distance above the passes through which it discharges into Galveston Bay is great, extensive shoals or bars exist at the bay ends of the passes, forming obstructions to navigation for the sail vessels that ply between Wallisville and Galveston. The reports of the engineer officers have recognized the importance of increasing the depth over the bar at the mouth of the principal pass.

Improvement of the bar was undertaken, as already noted, by the Government in 1878, and it has continued, though irregularly, keeping pace with appropriations as they have been made. The result of the improvements thus far has been to somewhat increase the depth, greater increase being looked for as the result of future appropriations.

The annual value of the commerce, mostly between Wallisville and Galveston, carried on by about 36 small sail vessels, amounts to about $75,000. The shipment of cotton by river had reduced in 1889 to 267 bales, and in 1890 to 130.

From all information gained it appears that the river between Magnolia and Dallas is as full of obstructions and as costly to improve as is the river below Magnolia, and I am unable to learn that there is any business, present or prospective, that would warrant even the cost, at this time, of further survey or examination of the river above its mouth with a view to improvement.

I am constrained to report, therefore, that the Trinity River between its mouth and Dallas can not be regarded, at present, as worthy of improvement by the General Government.

Very respectfully, your obedient servent,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, February 16, 1891.

Respectfully forwarded to the Chief of Engineers.

I concur with Major Allen in the opinion that Trinity River from its mouth to Dallas is not worthy of improvement.

C. B. COMSTOCK,
Col. of Engrs., Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Digitized by Google

U 9.

PRELIMINARY EXAMINATION OF COLORADO RIVER, TEXAS, WITH A VIEW OF REMOVING RAFT AT MOUTH OF SAME.

[Printed in House Ex. Doc. No. 138, Fifty-first Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 30, 1890.

SIR: I have the honor to submit the accompanying copy of report dated December 20, 1890, by Maj. Chas. J. Allen, Corps of Engineers, giving results of a preliminary examination of Colorado River, Texas, with a view of removing raft at mouth of same, made in compliance with requirements of the river and harbor act approved September 19, 1890.

In view of the fact that the cost of the improvement would be heavy, and that there is no present river commerce to be benefited, and the value of the prospective commerce is exceedingly doubtful, it is the opinion of Major Allen and of the Division Engineer, Col. C. B. Comstock, Corps of Engineers, that the locality is not at present worthy of improvement by the United States.

The views of these officers are concurred in by me.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. REDFIELD PROCTOR,
Secretary of War.

REPORT OF MAJOR CHARLES J. ALLEN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., December 20, 1890.

GENERAL: I have the honor to submit the following report of a preliminary examination of Colorado River, Texas, with a view of removing raft at mouth of same, made in compliance with sections 17 and 18 of the river and harbor act of Congress approved September 19, 1890.

The Colorado River has its sources in Dawson, Martin, and Midland counties. After traversing about 450 miles of country it discharges into Matagorda Bay, at the town of Matagorda, which is distant from Pass Cavallo about 35 miles. Pass Cavallo is the channel connecting the bay with the Gulf of Mexico. The river is crossed by several railroads, the most southerly, the Texas and Mexican Railway, crossing at Wharton, about 50 miles above the mouth of the river.

An examination of the Colorado at and for a number of miles above its mouth was made during the present month, under my direction, by Mr. W. A. Hinkle, of this office. A copy of his report is herewith.

It appears from that report that the river is obstructed for about 22 miles above its mouth by several rafts or accumulations of timber. The first raft is about 75 to 100 feet in width and about 150 to 200 feet long. At points respectively distant about 1 and 3 miles above the raft just mentioned are rafts 200 and 400 feet long. The largest raft is situated about 22 miles above the mouth of the river and is about 4 miles long, from 200 to 300 feet wide, and 25 to 50 feet deep. The raft

Digitized by Google

at its upper end rises to within 3 feet of the top of the bank, which, in the ordinary low-water condition of the stream, was about 30 feet above the water surface.

These rafts act as dams, obstructing the flow of water and, during times of freshet, cause the overflow of many square miles of valuable land. In some cases the obstructed waters find their way across the country to the valleys of neighboring streams, entailing considerable losses to farmers and others.

There is no present commence on the river. It is said that before the rafts formed boats ascended as far as Elliott's Ferry, about 21 miles above the river mouth, and that they transported cotton, which now has to be hauled by wagon to Matagorda for shipment, and it is claimed that the removal of the rafts will be followed by a large steamboat navigation of the stream. The principal, if not the main, benefit to be derived from removing the obstructions would consist in the reduction of overflow.

The cost, however, of removing the rafts would be heavy, and as there is no present river commerce to be benefited by such removal, and as the value of the prospective river commerce is exceedingly doubtful, I am constrained to report that the locality is not at present worthy of being improved by the United States Government.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, December 27, 1890.

Respectfully forwarded to the Chief of Engineers.

The opinion of the district officer that this river is not worthy of improvement is concurred in.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

LETTER OF MR. W. A. HINKLE, INSPECTOR.

GALVESTON, TEX., *December 18, 1890.*

MAJOR: According to letter of instructions dated November 29, 1890, I proceeded to mouth of Colorado River and made examination of the raft. I was delayed several days in my departure by work in the office and waiting for transportation.

I left Galveston December 9, at 6:15 p. m., per steamship *Cumberland,* and arrived at the oyster reefs in Matagorda Bay on 10th at 2:30 p. m., and failing to get transportation to the shore—the town of Matagorda—remained on board until the morning of 11th and landed at the town at 11 a. m. Arranged for team to go up to the big raft on following morning, and securing a small boat and two oarsmen, proceeded, in company with Mr. J. H. Selkirk, county treasurer of Matagorda, to the first raft, some 5 miles up from the mouth of the Colorado River. This raft is in a narrow part of the stream about 75 to 100 feet wide and about 150 to 200 feet long.

There are two more rafts, 1 and 3 miles respectively, above the first one, but dark coming on I did not see them. Mr. Selkirk informs me that they are somewhat larger than the one I saw, but not exceeding 200 to 400 feet in length, and that from there up the river is clear of obstructions for several miles. On the morning of

Digitized by Google

the 12th I started with the team for the head of the big raft, about 17 miles distant in an air line. This raft is, as well as I could judge, about 4 miles long and 200 to 300 feet wide and 25 to 50 feet deep. At the "Bluffs" near the head of raft—so called from the banks being about 30 feet above the water before the raft formed—I found the timber and water in the raft about 3 feet below the level of the bank and seemingly of recent formation. The lower end of the raft is in more or less detached sections, showing a natural decay of the timber.

I talked to a number of farmers, who say they have been compelled to abandon the land adjacent to the river and move back on the higher prairie land. I saw numerous places on the prairie where the overflow had crossed to the adjacent streams. I saw only the east side of the river, but am informed that the west side is similar. I should judge from what I saw that there is from 1 to 2 miles submerged on east side of the river, and where it flows across over the two parts of the high prairie even 10 miles. I am told that the backwater goes to Wharton and beyond.

I think the removal of the raft will be costly and difficult, and an easier solution of the problem would be to cut a channel around it on the west side, where there is a chain of lakes and a present constant current with a depth of 2 to 15 feet. This chain of lakes and flow of water between is obstructed by timber, mostly dead.

To make the river navigable it would be necessary to remove a great number of overhanging trees, in addition to the removal of the rafts. There is no present commerce on the river, as it is entirely blocked by the raft. I could get no data of the former commerce of the river, except that the boats ascended as far as Elliott Ferry and transported cotton, etc., to Matagorda, 21 miles distant. This cotton is now hauled to the town by teams, a tedious job when the roads are in bad order from rains. Mr. D. P. Moore, at Elliott, has the only cotton gin I saw during the trip.

I am indebted to Mr. D. P. Moore and to Mr. J. H. Selkirk, of Matagorda, for much information in regard to the river. I inclose letters from those gentlemen, also a sketch* made from land office map for Matagorda County. The light blue indicates the submerged land during overflow; dark blue, the chain of lakes and present flow of water, blue dots show where cut could be made to take the flow of water, red dots show the location of the rafts. The entrance to the Colorado River is said to have about 2-feet depth of water, and the river from 10 to 40 feet.

Very respectfully, your obedient servant,

W. A. HINKLE,
Inspector.

Maj. CHAS. J. ALLEN,
Corps of Engineers, U. S. A.

LETTER OF MR. J. H. SELKIRK, COUNTY TREASURER.

MATAGORDA, TEX., *December 15, 1890.*

DEAR SIR: At your request I give you my views as to the benefit derived from the opening of the Colorado River by removing the raft or otherwise. There is a fine body of farming land lying on each side of the river, and which overflows fully a mile out on both sides and for a distance of about 17 miles. A number of families have had to move out on the prairie on account of this overflow, and abandon their fine farms of alluvial soil and go to the prairie. This raft now is so far up (and every year getting higher up and worse) that the water runs over into Big Boggy, a creek about 8 miles from Matagorda, overflowing its banks and ruining a number of farms. Also doing the same thing with Peyton Creek, about 15 miles out, and on the west side Wilson Creek, and in a few more years it will run into Caney Creek and destroy some of the finest plantations in the country; then the towns of Wharton and Columbus will suffer, and the farming interests suffering from these overflows will be immense. Then if it could be made navigable there would be an immense commerce developed, and by opening it up it would regain these lands and make the commerce, besides what is already there.

I hand you a sketch* made by Mr. D. P. Moore, he having gone over the ground; also a map* of the county, which will be of some service to you in making your report. The sketch only shows the upper part of the raft, which is the worst. There are several small rafts below and nearer the mouth, which would have to be removed to give the water an opening to the bay, which I think would not cost much.

---

* Not printed.

Digitized by Google

I would advise doing the work before the spring rises, and in the winter, as the weeds and undergrowth are dead then, while in the summer months it would be a hard matter to work on it.

Trusting you will make a favorable report on the same, I am,

Yours truly,

J. H. SELKIRK.

Mr. W. A. HINKLE.

LETTER OF MR. D. P. MOORE.

ELLIOTT, MATAGORDA COUNTY, TEX., *December 18, 1890.*

DEAR SIR: In reply to your inquiry as to past, present, or probable future commerce of the Colorado River at this place now obstructed by raft, will say that I have no data by which I can answer first part of question, and as to second, owing to complete obstruction by raft, there is no traffic whatever on this river now, but with the removal of this raft and the consequent redemption from overflow of, say, 40,000 or 50,000 acres of alluvial farming lands in this county, which lands will produce 40 or 50 bushels of corn and three-fourths of a bale of cotton per acre, worth $40 per bale, I see no reason why a commerce amounting to $700,000 or $800,000 per annum should not be developed at once, and I firmly believe that such would be the case upon the removal of this obstruction to navigation and the redemption of these fine lands from overflow, a large part of which have been and are being abandoned on this account. This does not include any part of the produce from the fine farming counties of Wharton and Colorado, through which the river flows, which counties formerly shipped a large per cent. of their produce this way, and would probably do so again if the river was open to navigation.

I am, very respectfully, yours,

D. P. MOORE.

Mr. W. A. HINKLE.

U 10.

PRELIMINARY EXAMINATION OF ARANSAS BAY, TEXAS, TO REMOVE HALF-MOON REEF; AND OF ST. CHARLES BAY, TEXAS, WITH A VIEW OF REMOVING OBSTRUCTIONS AT MOUTH OF SAME.

UNITED STATES ENGINEER OFFICE,
Galveston, Tex., March 24, 1891.

GENERAL: I have the honor to report as follows in regard to preliminary examinations of the following-named localities in Texas, made in compliance with sections 17 and 18 of the river and harbor act of Congress approved September 19, 1890. "Aransas Bay to remove Half-Moon Reef," and "St. Charles Bay, with a view of removing obstructions at mouth of same."

These localities are shown on United States Coast Survey Chart No. 109, of 1884. St. Charles Bay is an arm of Aransas Bay, Texas, and distant about 20 miles in a northerly direction from Aransas Pass, which connects Aransas Bay with the Gulf of Mexico. The improvement of the pass is in the hands of a private corporation.

St. Charles Bay is about 11 miles long and of about 1½ miles average width. There is a shoal at its mouth upon which the ruling depth at mean low tide is about 2 feet, the ruling depth in the bay, for a distance of 6 miles from its mouth being, at the same stage of water, about 4 feet; beyond that distance the depth decreases somewhat.

Half-Moon Reef is directly opposite and distant about 3 miles from the mouth of St. Charles Bay, being separated from the shoal at the mouth of the bay by a deep pocket. The depth of water on the reef varies from 6 inches to about 4 feet at mean low tide, according to the chart, the ruling depth being probably but little more than 2 feet.

Digitized by Google

Between this reef and Long Reef, just to the south of it, there appears a narrow pass having about 3¾ feet depth of water. But the former reef being directly in the path of vessels bound for St. Charles Bay, it and the shoal at the mouth of the latter constitute obstructions to the entrance to the bay, and on account of their proximity and relation to each other have to be considered and reported upon together.

There are no regular freight-carrying vessels navigating St. Charles Bay. The vessels that navigate the bay are few in number and of small size, their draft being from 1½ to 2½ feet. Their business consists generally in carrying materials to the farms which are beginning to occupy both shores of the bay. As farms and settlements multiply, the navigation may be expected to increase, though to what extent can not now be stated even approximately.

On the westerly shore of Aransas Bay and opposite to St. Charles Bay is the rapidly growing town of Rockport, which will undoubtedly sustain considerable commerce through Aransas Pass. But Half-Moon Reef is entirely beyond the path of vessels plying between Rockport and the pass, and consequently offers no obstruction to that commerce.

I am unable to discover any reason for the United States Government undertaking an improvement, at present at least, at St. Charles Bay and Half-Moon Reef, and am therefore of opinion that these localities should not be classed as worthy of improvement by the General Government.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. C. B. Comstock, Corps of Engineers, Division Engineer, Southwest Division.)

[First Indorsement.]

U. S. ENGINEER OFFICE,
SOUTHWEST DIVISION,
New York, March 30, 1891.

Respectfully forwarded to the Chief of Engineers.

I concur in the opinion of the local engineer that these places are not at present worthy of improvement by the United States.

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
Division Engineer.

Digitized by Google

Digitized by Google

INDEX.

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
A.						
Aberdeen, Wash., bridging Chehalis River at	430					
Acts of Fifty-first Congress, second session, affecting Corps of Engineers	477					
Agate Bay Harbor, Minn., improvement of	311			2486		
Ahnapee Harbor, Wis., improvement of	321			2538		
Alabama River, Ala., improvement of	204		1738			
Alabama River, Ala., up to Wetumpka, examination of	211		1761			
Albemarle Sound, N. C., and Norfolk Harbor, Va., water way between, improvement of	151	1302				
Alexandria, La., bridging Red River near	430					
Allegheny Bridge Company, bridge of, across Allegheny River, Pa	431					
Allegheny River, Pa., at Sixth street, Pittsburg, bridging	431					
Allegheny River, Pa., dam at Herr Island, construction of	292			2366		
Allegheny River, Pa., improvement of	292			2363		
Allouez Bay, at Superior, Wis., examination of	316			2512		
Alloway Creek, N. J., improvement of	117	1086				
Alsea Bay, Oregon, examination of	409				3246	
Alsea River, Oregon, examination of	409				3246	
Altamaha River, Ga., improvement of	181		1531			
Alton, Ill., bridging Mississippi River at	432					
Alviso Creek, Cal., examination of	393				2964	
Alviso Harbor, Cal., examination of	393				2964	
Amesbury, Mass., bridge across Powow River at	427					
Amite River, La., improvement of	223		1820			
Anacostia River. (*See* Eastern Branch of Potomac River.)						
Annie J. Russell (schooner), removal of wreck of	32 609					
Apalachicola Bay, Fla., improvement of	196		1694			
Apalachicola River, Fla., improvement of	197		1696			
Appomattox River, Va., improvement of	150	1300				
Appoquinnimink River, Del., improvement of	121	1161				
Approaches to Norfolk Harbor, Va., improvement of	146 147	1291 1296				
Aqueduct, Washington, maintenance and repair of	436					3875
Aquia Creek, Va., improvement of	139	1255				
Aransas Bay, Tex., examination for removal of Half-Moon Reef	235		1942			
Arkansas River, Ark., at Dardanelle, bridging	430					
Arkansas River, Ark., Ind. T., and Kans., improvement of	250			2037		
Arkansas River, Ark., Ind. T., and Kans., removing obstructions in	249			2033		
Arthur Kill, N. Y. and N. J., improvement of	97	983				
Arthur, Lake, La., course of Mermenton River through, examination and survey of	230		1858			
Ashland Harbor, Wis., improvement of	313			2500		
Ashley River, S. C., bridge obstructing	433					
Ashley River, S. C., improvement of	176	1476				
Ashtabula Harbor, Ohio, improvement of	372				2863	
Astoria Harbor, Oregon, establishment of harbor lines in	18 427				3387	
Astoria, Oregon, and Woods Landing, Columbia River between, examination for snagging	420				3380	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Astoria, Oregon, wreck in Columbia River near, removal of	420				3373	
Atchafalaya River, La., to Cottonport, Bayou des Glaises from, examination of	230		1854			
Atlantic City, thoroughfare between Great Bay north of, and Cape May, N. J., examination of	118	1097				
Augusta, Ga., bridge obstructing Savannah River below	435					
Augusta, Me., and Waterville, Me., Kennebec River between, examination and survey of	33					
Au Sable Harbor, Mich., improvement of	351				2771	
B.						
Back Cove, Portland, Me., bridge obstructing channel to	435					
Back Cove, Portland, Me., improvement of channel in	27 597					
Bagaduce River, Me., improvement of	22 578					
Baltimore, Pa., and Tionesta, Tionesta Creek between, examination of	294			2381		
Baltimore and Ohio Southwestern Railroad Company, bridge of, obstructing Muskingum River, Ohio	434					
Baltimore Harbor, Md., improvement of	132	1227				
Barnegat Bay and Great Egg Harbor Bay, N. J., sound between, examination of	118	1093				
Barnegat Inlet, N. J., removal of wreck in	118	1090				
Barnstable, Mass., bridging channel between Little Island and mainland at Osterville, in town of	431					
Barren River, Ky., operating and keeping in repair lock and dam on	304			2439		
Bartholomew, Bayou, La. and Ark., improvement of	240			1982		
Bath, Me., Kennebec River at, establishment of harbor lines in	18 424 622					
Battalion of Engineers	15 540					
Batteries, construction of	5					
Bay Ridge Channel, New York Harbor, N. Y., examination of	94 940					
Bay Ridge Channel, New York Harbor, N. Y., improvement of	90 917					
Bay River, N. C., and Pamlico River, N. C., water way between, examination of	170	1421				
Bayou Bartholomew, La. and Ark., improvement of	240			1982		
Bayou Black, La., and Bayou Terrebonne, examination for connection between	229		1846			
Bayou Black, La., for connection between Calcasieu Lake and Sabine Lake, examination of	230		1850			
Bayou Bœuf, La., improvement of	241			1985		
Bayou, Buffalo, Tex., improvement of	234		1924			
Bayou Carlin, La., examination of	229		1838			
Bayou Castor, La., examination of	249			2028		
Bayou, Cedar, Tex., improvement of	233		1922			
Bayou Chevreuil, La., examination of	229		1841			
Bayou Cocodrie, St. Landry Parish, La., examination of	229		1849			
Bayou Courtableau, La., improvement of	225		1826			
Bayou, Cypress, and lakes between Jefferson, Tex., and Shreveport, La., survey of	248			2021		
Bayou D'Arbonne, La., improvement of	240			1980		
Bayou des Glaises, La., from Atchafalaya River to Cottonport, examination of	230		1854			
Bayou, Double, Chambers County, Tex., mouth of, examination of	235		1933			
Bayou La Fourche, La., improvement of	224		1821			
Bayou, La Grange, Fla., improvement of	200		1704			
Bayou Maçon, La., improvement of	241			1989		
Bayou Manchac, La., improvement of	223		1820			
Bayou Plaquemine, La., bridge obstructing	434					
Bayou Plaquemine, La., improvement of	225		1824			
Bayou Plaquemine, La., securing mouth of, from further caving	231		1867			
Bayou Rondeway, La., improvement of	242			1992		
Bayou, Steele, Miss., improvement of	244			2005		
Bayou Teche, La., between St. Martinsville and Port Barre, examination of	230		1852			
Bayou Teche, La., improvement of	226		1828			

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Bayou Terrebonne, La., and Bayou Black, examination for connection between	229		1846			
Bayou Terrebonne, La., between Houma and Thibodeaux, examination of	229		1843			
Bayou Terrebonne, La., improvement of	224		1823			
Bayou Tigre, La., examination of	229		1841			
Bayou Vermillion, bay and passes, La., examination of	230		1855			
Bayou Vidal, La., improvement of	242			1992		
Bayou, Washington, Miss., improvement of	244			2005		
Beaufort Harbor, N. C., improvement of	161	1367				
Beaufort, N. C., and New Berne, N. C., water way between, improvement of	160	1363				
Beaufort, N. C., and New River, N. C., water way between, improvement of	162	1372				
Beaufort River, S. C., improvement of	178	1485				
Beaver River, Pa., movable dam in Ohio River near mouth of, construction of	290			2354		
Bee Tree Shoals, Ala., foot of, and Chattanooga, Tenn., Tennessee River between, improvement of	286			2303		
Bee Tree Shoals, Ala., Tennessee River below, improvement of	279			2255		
Belfast Harbor, Me., improvement of	23 586					
Bellamy River, N. H., improvement of	30 605					
Ben Hur (tender), removal of wreck of	362				2801	
Benjamin Gartside (schooner), removal of wreck of	61 731					
Berwick Bay, La., to Gulf of Mexico, examination of	229		1847			
Bickmore, S. S. (schooner), removal of wreck of	62 732					
Big Barren River, Ky., above Bowling Green, examination of	310			2474		
Big Barren River, Ky., Green River above mouth of, examination of	310			2478		
Big Black River, Miss., improvement of	242			1993		
Big Blackfoot River, Mont., mouth of, and international boundary line, Clark Fork of Columbia River between, examination of	409				3250	
Big Hatchee River, Tenn., improvement of	246			2010		
Big Sandy River, Levisa Fork of, Ky., improvement of	307			2466		
Big Sandy River, Russel Fork of, Ky., examination of	310			2476		
Big Sandy River, Tug Fork of, 91 and 95½ miles above Catlettsburg, Ky., bridging	431					
Big Sandy River, Tug Fork of, W. Va. and Ky., improvement of	308			2467		
Big Sandy River, W. Va. and Ky., improvement of	307			2463		
Big Sioux River, mouth of, and north line of South Dakota, Missouri River between, examination and survey of	277			2242		
Big Stone Lake, Minn. and S. Dak., examination and survey of	274					
Big Sunflower River, Miss., improvement of	245			2007		
Bills authorizing construction of bridges, examination of	18					
Biloxi Harbor, Miss., improvement of	219		1793			
Black, Bayou, La., and Bayou Terrebonne, examination for connection between	229		1846			
Black, Bayou, La., for connection between Calcasieu Lake and Sabine Lake, examination of	230		1850			
Black Lake Harbor, Mich., improvement of	341				2690	
Black River, Ark. and Mo., improvement of	254			2055		
Black River, Ark. and Mo., obstruction of, by logs, and injury to dam on						3868
Black River Harbor, Ohio, improvement of	369				2849	
Black River, La., improvement of	238			1964		
Black River, Mich., at Port Huron, improvement of	354				2780	
Black River, Mich., mouth of, improvement of	355				2782	
Black River, Mo., improvement of	255			2058		
Black River, N. C., improvement of	164	1387				
Black River, S. C., below Kingstree, examination of	170	1435				
Black River, Wash., examination of	409				3257	
Black Rock Harbor, Conn., improvement of	70 784					
Black Warrior River, Ala., between Tuscaloosa and Daniels Creek, improvement of	215		1784			

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Block Island, R. I., harbor of refuge at	59 723					
Blue Hill Harbor, Me., examination of	32 611					
Bluff Creek, Miss., improvement of	218		1702			
Board of Engineers, The	11					
Boards:						
On examination for deep-water harbor on Pacific coast between Points Duma and Capistrano, Cal	394					
On examination for harbor of refuge near mouth of Delaware Bay	119	1120				
On examination for ship canal to connect Lakes Union, Washington, and Samamish with Puget Sound, Wash	412					
On improvement of Hudson River, N. Y.	82 866					
On improvement of Sacramento and Feather rivers, Cal	396				2990	
On investigation of mining-débris question in California	399				2996	
On reëxamination of Port Orford Harbor, Oregon	411				3305	
On survey for improvement of Wilmington Harbor, Del	120	1138				
On valuation of channel constructed by Buffalo Bayou Ship Channel Company in Galveston Bay, Tex	233		1906 1910			
Bœuf, Bayou, La., improvement of	241			1985		
Bœuf River, La., improvement of	241			1985		
Bogue Chitto, La., improvement of	220		1800			
Bogue Falia, La., improvement of	222		1818			
Bogue Sound, N. C., improvement of		1372				
Boquet River, N. Y., below Willsboro, examination of	388				2940	
Boston Harbor, Mass., construction of casemates at	6					
Boston Harbor, Mass., defense of	5 6					
Boston Harbor, Mass., establishment of harbor lines in	18 424 688					
Boston Harbor, Mass., improvement of	40 645					
Bowling Green, Ky., Big Barren River above, examination of	310			2474		
Brazos River, Tex., below Waco, examination of	235					
Brazos Santiago Harbor, Tex., improvement of	234		1930			
Breakwaters:						
At Gordon Landing, Lake Champlain, Vt.	385				2930	
At mouth of Saco River, Me	28 598					
At New Haven, Conn	68 766					
At Rouse Point, Lake Champlain, N. Y.	384				2927	
From Mount Desert to Porcupine Island, Me	21 576					
Occupancy of and injury to, by corporations or individuals	19 436					3363
Breton Bay, Md., harbor at, improvement of	140	1258				
Bridgeport Harbor, Conn., improvement of	70 778					
Bridges, examination of bills authorizing construction of	18					
Bridges in Yellowstone National Park, construction and improvement of	447					3931
Bridges obstructing navigation	18 433					
Bridges proposed to be built across navigable waters, examination of plans and locations of	18 427					
Bridging navigable waters of United States	18 427					3363
Broad Creek, Md., examination and survey of	132	1221				
Broad Creek River, Del., examination of	131	1209				
Broadkiln River, Del., improvement of	122	1107				
Bronx River, N. Y., examination and survey of	94 949					
Browns Creek, Sayville, N. Y., improvement of	79 828					
Bruce (bark), removal of wreck of	228		1837			
Brunswick, Ga., outer bar, examination and survey of	185					
Brunswick Harbor, Ga., improvement of	182		1550			
Buckhannon River, W. Va., improvement of	309			2474		
Budd Inlet, Olympia Harbor, Wash., from, examination and survey of	411					
Buffalo Bayou Ship Channel Company, valuation of channel constructed in Galveston Bay, Tex., by	233		1906 1910			
Buffalo Bayou, Tex., improvement of	234		1924			

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Buffalo Harbor, N. Y., improvement of	375				2882	
Buffalo Harbor, N. Y., occupancy of north pier at						3872
Buffalo, N. Y., ship channel in connecting waters of the Great Lakes between, Chicago and Duluth, examination of	362				2810	
Building materials, tests of	551 565					
Buildings, public, D. C., improvement and care of	444					3907
Burlington Harbor, Vt., improvement of	386				2932	
Buttermilk Channel, New York Harbor, N. Y., examination of	93 937					
Buttermilk Channel, New York Harbor, N. Y., improvement of	88 911					
C.						
Cable City Bridge Construction Company, bridge of, across Arkansas River at Dardanelle, Ark	430					
Cable galleries, construction of	6					
Cache River, Ark., improvement of	253			2051		
Cahaba River, Ala., improvement of	210		1754			
Calcasieu Lake, La., and Sabine Lake, connection between, via Bayou Black, examination of	230		1850			
Calcasieu River, La., mouth and passes of, improvement of	226		1829			
California, investigation of mining-débris question in	399				2996	
Caloosahatchee River, Fla., improvement of	189		1643			
Calumet Harbor, Ill., improvement of	330			2602		
Calumet River, Ill. and Ind., improvement of	331			2606		
Cambridge Harbor, Md., improvement of	127	1191				
Camden, Ark., Ouachita River above, improvement of	239			1975		
Camden Harbor, Me., improvement of	24 587					
Camden, N. J., establishment of harbor lines at	425	1122				
Camden, N. J., harbor at, improvement of	110	1029				
Camden, S. C., Wateree River between, and Falls of the Catawba; and bend about 4 miles below, examination of	179	1487				
Canals:						
Cascades Canal, Columbia River, Oregon, construction of	414				3328	
Coosa River, Ga. and Ala., operating and care of locks and dams, etc., on	210		1753			
Des Moines Rapids Canal, operating and care of	266			2174		
Fox River, Wis., operating and care of locks and dams on	329			2580		
Great Kanawha River, W. Va., operating and care of locks and dams on	300			2425		
Green and Barren rivers, Ky., operating and keeping in repair locks and dams on	304			2439		
Illinois and Mississippi Canal, construction of	334			2633		
Illinois River, Ill., operating and care of La Grange Lock	333			2630		
Kentucky River, Ky., operating and keeping in repair locks and dams on	306			2455		
Louisville and Portland Canal, Ky., operating and care of	296			2394		
Monongahela River, operating and care of Locks and Dams Nos. 8 and 9	291			2357		
Monongahela River, purchase of Lock and Dam No. 7	291			2359		
Monongahela River, purchase of Lock and Dam No. 6	291			2360		
Muscle Shoals Canal, Tennessee River, operating and care of	287			2322		
Muskingum River, Ohio, operating and care of locks and dams on	293			2369		
Portage Lake, Mich., with Lake Superior and Keweenaw Bay, purchase of canals connecting	17					
St. Clair Flats Canal, Mich., improvement of	356				2784	
St. Clair Flats Canal, Mich., operating and care of	358				2787	
St. Marys Falls Canal, Mich., operating and care of	346				2724	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Canapitsit Channel, Mass., examination and survey of	62					
Canarsie Bay, N. Y., improvement of	95	980				
Cane River, Laexamination of	249			2022		
Caney Fork River, Tenn., improvement of	284			2284		
Cape Ann, Mass., harbor of refuge at Sandy Bay	36 632					
Cape Charles City Harbor, Va., and approaches by Chenton (Cherrystone) Inlet, improvement of	130	1199				
Cape Fear, North East River, N. C., improvement of	164	1383				
Cape Fear River, N. C., above Wilmington, improvement of	165	1300				
Cape Fear River, N. C., at and below Wilmington, improvement of	106	1304				
Cape May and Great Bay north of Atlantic City, N. J., thoroughfare between, examination of	118	1097				
Cape May City, N. J., examination for breakwater at	118	1099				
Capistrano Point and Point Dume, Cal., deep-water harbor on Pacific coast between, examination for	394					
Carlin, Bayou, La., examination of	229		1638			
Carquines Strait, Cal. (*See* Karquines Strait.)						
Carthage, Miss., and Edinburg, Miss., Pearl River between, improvement of	220		1799			
Carthage, Miss., and Jackson, Miss., Pearl River between, improvement of	220		1797			
Cascades Canal, Columbia River, Oregon, construction of	414				3328	
Casemates, construction of	6					
Castor, Bayou, La., examination of	249			2028		
Catawba, Falls of the, and Camden, Wateree River, S. C., between, examination of	179	1487				
Catlettsburg, Ky., bridging Tug Fork of Big Sandy River, 91 and 95½ miles above	431					
Cedar Bayou, Tex., improvement of	233		1022			
Cedar Keys, Fla., Boat or Number Four Channel north and west of, examination of	195		1676			
Cedar Keys, Fla., harbor at, improvement of	193		1661			
Cedar River Harbor, Mich., improvement of	318			2525		
Cerullus (schooner), removal of wreck of	32 610					
Champlain, Lake, Narrows of, N. Y. and Vt., improvement of	387				2937	
Champlin Creek, N. Y., examination of	94 942					
Channel between Staten Island and New Jersey, improvement of	98	986				
Channel in Back Cove, Portland, Me., improvement of	27 597					
Channel in connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, examination of	362				2810	
Channel north and west of Cedar Keys, Fla., examination of	195		1676			
Charleston and South Side Bridge Company, bridge of, across Great Kanawha River, W. Va.	429					
Charleston Harbor, S. C., construction of casemate at	6					
Charleston Harbor, S. C., improvement of	175	1467				
Charleston Harbor, S. C., removal of wreck in South Channel across bar	178	1487				
Charleston, W. Va., bridging Great Kanawha River at	429					
Charlevoix Harbor, Mich., improvement of	336				2673	
Charlevoix, Mich., bridging Pine Lake near	432					
Charlotte Harbor, Fla., examination of	196		1681			
Charlotte Harbor, Fla., improvement of	190		1646			
Charlotte Harbor, N. Y., improvement of	378				2899	
Charts of northern and northwestern lakes, printing and distribution of	445					3927
Chatham Harbor, Mass., improvement of	46 667					
Chattahoochee River, Ga. and Ala., between West Point and Franklin, examination of	211		1756			
Chattahoochee River, Ga. and Ala., improvement of	199		1702			
Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala., Tennessee River between, improvement of	280			2303		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Chattanooga, Tenn., Tennessee River above, improvement of	278			2252		
Chattanooga, Tenn., Tennessee River below, improvement of	287			2311		
Cheat River, W. Va., improvement of	291			2361		
Cheboygan Harbor, Mich., improvement of	348				2764	
Chefuncte River, La., improvement of	222		1818			
Chehalis River, Wash., below Montesano, examination and survey of	411				3297	
Chehalis River, Wash., between Aberdeen and Cosmopolis, bridging	430					
Chehalis River, Wash., improvement of	407				3236	
Chenton Inlet, Cape Charles City Harbor, Va., and approaches by, improvement of	130	1199				
Cherrystone Inlet, Cape Charles City Harbor, Va., and approaches by, improvement of	130	1199				
Chesapeake Bay, harbor of refuge at Lynnhaven Bay, foot of, Va., examination and survey for	146					
Chesapeake Bay, removal of wreck in		1201				
Chester River, Md., from Crumpton to Jones Landing, improvement of	126	1188				
Chester River, Md., removal of wreck in Jackson Creek	131	1201				
Chevreuil, Bayou, La., examination of	229		1841			
Chicago and North Michigan Railroad Company, bridge of, across Pine Lake, Mich.	432					
Chicago and North-Western Railway Company, bridges of, across Chicago River, Ill.	432					
Chicago Harbor, Ill., establishment of harbor lines in	18 426			2661		
Chicago Harbor, Ill., improvement of	329			2596		
Chicago, Ill., bridge of city of, obstructing Chicago River at Canal street	436					3861
Chicago, Ill., bridging North Branch of Chicago River near Kinzie street	432					
Chicago, Ill., ship channel in connecting waters of the Great Lakes between, Duluth, and Buffalo, examination of	362				2810	
Chicago River, Ill., at Canal street, Chicago, bridge obstructing	436					3861
Chicago River, Ill., near Kinzie street, Chicago, bridging North Branch of	432					
Chickahominy River, Va., between Holly Landing and Long Bridge, examination of	153	1305				
Chickahominy River, Va., improvement of	149	1299				
Chickasahay River, Miss., improvement of	218		1791			
Chief of Engineers, office of the	451					
Chincoteague Bay, Va., and Delaware Bay, at or near Lewes, Del., water way between, improvement of	123	1168				
Chippewa River, Wis., including Yellow Banks, improvement of	270			2201		
Chippewa River, Wis., survey for reservoirs at sources of				2214		
Chitto, Bogue, La., improvement of	220		1800			
Choctawhatchee River, Fla. and Ala., improvement of	201		1707			
Choptank River, Md., improvement of	127	1189				
Christians Point, West Galveston Bay, Tex., from, examination and survey of	235					
Clackamas Rapids, Oregon, Willamette River at, examination and survey of	421					
Clarendon, Ark., and Lower White River, examination and survey of	257					
Clark Fork of Columbia River, Wash., Idaho, and Mont., between international boundary line and mouth of Big Blackfoot River, examination of	409				3250	
Clark River, S. C., improvement of	172	1453				
Clarke, Lewis and, River, Oregon, examination and survey for snagging	421				3383	
Clay County, Mo., bridging Missouri River at	432					
Clearwater River, Idaho, about 11 miles above Lewiston, bridging	431					
Cleveland Harbor, Ohio, improvement of	370				2853	
Clinch River, Tenn., improvement of	281			2264		
Clinton and Illinois Bridge Company, bridge of, across Mississippi River at Clinton, Iowa	428					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Clinton Harbor, Conn., improvement of	66 750					
Clinton, Iowa, bars north of Little Rock Island, in Mississippi River near, examination and survey for removal of	267			2187		
Clinton, Iowa, bridging Mississippi River near	428					
Clinton River, Mich., improvement of	358				2788	
Clubfoot River, N. C., improvement of		1363				
Coal Bank Slough, Coos County, Oregon, bridging	432					
Coanjok Bay, N. C., improvement of	152	1305				
Coaster Harbor Island, R. I., cove and water way near, improvement of	57 718					
Cocheco River, N. H., improvement of	31 607					
Cocodrie, Bayou, St. Landry Parish, La., examination of	229		1849			
Collins Crossing, N. C., and Roberts Landing, N. C., White Oak River between, examination of	170	1434				
Colorado River, Ariz., between Yuma and Eldorado Canyon, examination of	393				2974	
Colorado River, Tex., examination for removal of raft at mouth of	235		1939			
Columbia, Department of the, report of acting engineer officer on operations in	450					3945
Columbia, La., bridging Ouachita River near	430					
Columbia River, Oregon and Wash.:						
Bridging, near Vancouver, Wash	429					
Construction of canal at Cascades, Oregon	414				3328	
Examination and survey of, between mouth of Willamette River, Oregon, and Vancouver, Wash	421					
Examination and survey of Columbia and Willamette rivers below Portland, Oregon	421					
Examination of, between Astoria and Woods Landing, Oregon, for snagging	420				3380	
Examination of channel from, to head of Youngs Bay, Oregon	420				3376	
Examination of Clark Fork of, Wash., Idaho, and Mont., between international boundary line and mouth of Big Blackfoot River	409				3250	
Gauging	419				3372	
Improvement of, between head of Rock Island Rapids and foot of Priest Rapids	406				3223	
Improvement of Columbia and Willamette rivers below Portland, Oregon	416				3362	
Improvement of mouth of	412				3314	
Improvement of Upper Columbia River	405				3210	
Removal of wreck in	420				3373	
Columbus, Miss., and Demopolis, Ala., Tombigbee River between, improvement of	215		1783			
Columbus (tug), wreck of			1605			
Commission on survey of Wilmington Harbor, Del	120	1138				
Commission on valuation of channel constructed by Buffalo Bayou Ship Channel Company in Galveston Bay, Tex	233		1906 1910			
Compton Creek and Shoal Harbor, N. J., improvement of	105	1004				
Conecuh River, Ala., improvement of	203		1735			
Congaree River, S. C., improvement of	174	1404				
Conneaut Harbor, Ohio, examination and survey of	373					
Connecticut River above Hartford, Conn., improvement of	64 748					
Connecticut River below Hartford, Conn., examination of	79 80 836					
Connecticut River below Hartford, Conn., improvement of	65 750					
Contentnia Creek, N. C., improvement of	158	1351				
Contingencies of rivers and harbors, examinations, surveys and, estimates for	421					
Coos Bay and Harbor, Oregon, entrance to, improvement of	401				3154	
Coos Bay, Oregon, examination and survey of upper harbor	410				3283	
Coos Bay, Roseburg and Eastern Railroad and Navigation Company, bridge of, across Coal Bank Slough, Oregon	432					
Coos County, Oregon, bridging Coal Bank Slough	432					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Coosa River between Rome, Ga., and East Tennessee, Virginia and Georgia Railroad Bridge, improvement of	208		1745			
Coosa River between Wetumpka, Ala., and East Tennessee, Virginia and Georgia Railroad Bridge, improvement of	208		1748			
Coosa River, Ga. and Ala., improvement of	207		1743			
Coosa River, Ga. and Ala., operating and care of canals and other works of navigation on	210		1753			
Coquille City, Oregon, and Myrtle Point, Coquille River between, examination and survey of	410				3275	
Coquille River, Oregon, between Coquille City and Myrtle Point, examination and survey of	410				3275	
Coquille River, Oregon, improvement of	399				3146	
Cornwall, N. Y., Moodna River (Murderers Creek) and Hudson River at, examination and survey of	94 944					
Corps of Engineers, battalion of	15 540					
Corps of Engineers, laws of Fifty-first Congress, second session, affecting	477					
Corps of Engineers, officers of	3					
Corps of Engineers, recommendations as to examinations for promotion of officers of	4					
Corps of Engineers, statement showing rank and duties of officers of	453					
Corsica Shoal, Mich., at lower end of Lake Huron, near St. Clair River, examination of	363				2820	
Corvallis, Oregon, Willamette River near, examination and survey of	421					
Cos Cob or Mianus River, Conn., examination and survey of	81 852					
Cosmopolis, Wash., bridging Chehalis River at	430					
Cottonport, La., to Atchafalaya River, Bayou des Glaises from, examination of	220		1854			
Council Bluffs, Iowa, bridging Missouri River at	431					
Courtableau, Bayou, La., improvement of	225		1826			
Courtland, Va., Nottoway River below, examination of	153	1315				
Cove near Coaster Harbor Island, R. I., improvement of	57 718					
Covington, Ga., to Ocmulgee River, Yellow River from, examination of	184		1606			
Cowlitz River, Wash., improvement of	418				3370	
Crane Creek, Va., examination of	146	1289				
Creel Bay, Devil Lake, N. Dak., examination of	274			2223		
Crooked River, Wash., examination of	420				3378	
Crookston, Minn., Red River of the North and tributaries above, examination and survey of	274					
Cross-over Light and Sister islands, N. Y., shoal in St. Lawrence River between, improvement of	383				2922	
Crumpton, Md., and Jones Landing, Chester River between, improvement of	126	1188				
Cumberland River, Tenn. and Ky.:						
Improvement of	282			2267		
Improvement of, above mouth of Jellico Creek, Ky	284			2275		
Improvement of, above Nashville, Tenn.	283			2270		
Improvement of, below Nashville, Tenn.	282			2268		
Improvement of South Fork of, Ky	285			2286		
Cumberland Sound, Ga. and Fla., improvement of	184		1559			
Current River below Van Buren, Mo., examination of	257			2065		
Currituck Sound, N. C., improvement of	152	1305				
Currituck Sound, N. C., water way between Norfolk Harbor, Va., and Albemarle Sound, N. C., through, improvement of	151	1302				
Curtis Bay, Patapsco River, Md., from Craighill channel to sugar refinery wharves at, examination of	135	1243				
Cuttyhunk and Neshawana islands, Mass., Canapitsit Channel, between, examination and survey of	62					
Cypress Bayou and lakes between Jefferson, Tex., and Shreveport, La., survey of	248			2021		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
D.						
Dallas, Tex., Trinity River below, examination of	235		1936			
Dam, Allegheny River, Pa., at Herr Island, construction of	292			2366		
Dam, Ohio River, at Davis Island, operating and care of	290			2350		
Dam, Ohio River, near mouth of Beaver River, Pa., construction of	290			2354		
Dams and locks. (*See* Locks and Dams.)						
Daniels Creek and Tuscaloosa, Ala., Black Warrior River between, improvement of	215		1784			
D'Arbonne, Bayou, La., improvement of	240			1980		
Dardanelle, Ark., bridging Arkansas River at	430					
Darien Harbor, Ga., improvement of	180		1528			
Davids Island, N. Y., sea wall and embankment at	6 9 521					
Davis Island Dam, Ohio River, operating and care of	290			2350		
Débris, mining, question in California, investigation of	399				2996	
Deep River, Wash., examination of	420				3378	
Deep-water harbor on Pacific coast between Points Duma and Capistrano, Cal., examination for	394					
De Grasse, Sylvia (ship), removal of wreck of	420				3373	
Delaware Bay:						
Construction of iron pier near Lewes, Del	114	1078				
Examination for harbor of refuge for deep-draft vessels near mouth of	119	1120				
Improvement of ice-harbor at head of, Del	113	1072				
Improvement of water way between Chincoteague Bay, Va., and, at or near Lewes, Del	123	1168				
Removal of wrecks in	118	1090				
Delaware Breakwater, Del., harbor at, improvement of	115	1075				
Delaware River at Philadelphia, Pa., and Camden, N. J., establishment of harbor lines in	425	1121				
Delaware River, Pa. and N. J., improvement of	108	1022				
Delaware River, removal of wrecks from	118	1090				
Demopolis, Ala., and Columbus, Miss., Tombigbee River between, improvement of	215		1783			
Demopolis, Ala., Tombigbee River below, improvement of	214		1783			
Department of the Columbia, report of acting engineer officer on operations in	450					3945
Department of the Platte, report of acting engineer officer on operations in	450					3946
Departments, military, estimates for surveys and reconnaissances in	450					
Departments, military, reconnaissances and explorations in	449					3943
Depot, engineer	16 547					
Des Allemands, Lake, La., and points near Vacherie, etc., bayous Chevreuil and Tigre between, examination of	229		1841			
Des Chutes River, Wash., Olympia Harbor to mouth of, examination and survey of	411					
Des Glaises, Bayou, La., from Atchafalaya River to Cottonport, examination of	230		1854			
Des Moines Rapids and Illinois River, Mississippi River between, improvement of	263			2119		
Des Moines Rapids and Minneapolis, Mississippi River between, improvement of	265			2147		
Des Moines Rapids canal and dry dock, operating and care of	266			2174		
Des Moines Rapids, Mississippi River, improvement of	266			2172		
Detroit River, Mich., American channel of, examination of	362				2808	
Detroit River, Mich., improvement of	361				2793	
Devil Lake, N. Dak., examination of	274			2222		
Dickinson, Frederick W., *et al.*, bridge of, in Barnstable, Mass	431					
Distribution of charts of northern and northwestern lakes	445					3927

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
District of Columbia, improvement and care of public buildings and grounds	444					3907
District of Columbia, water supply of	441					3897
Division engineers	19					
Division of the Missouri, report of engineer officer on operations in	449					3943
Division of the Pacific, report of acting engineer officer on operations in	450					3947
Divisions, Engineer	19					
Divisions, military, reconnaissances and explorations in	449					3943
Doboy and Sapelo, Ga., inside route between, examination and survey of	135					
Double Bayou, Chambers County, Tex., mouth of, examination of	235		1933			
Dozier Bridge, Va., West Neck River to and beyond, examination of	153	1324				
Drum Inlet, N. C., examination of	170	1425				
Dry dock at St. Marys Falls Canal, Mich	346				2758	
Dry dock, Des Moines Rapids, operating and care of	266			2174		
Dublin, Ga., bridging Oconee River near	429 430					
Duck Creek, Del. (*See* Smyrna River.)						
Duck Island Harbor, Conn., improvement of	66 757					
Duluth Harbor, Minn., and adjacent waters, establishment of harbor lines in	18 426			2515		
Duluth Harbor, Minn., improvement of	311			2488		
Duluth, Minn., ship channel in connecting waters of the Great Lakes, between, Chicago and Buffalo, examination of	362				2310	
Duma, Point, and Point Capistrano, Cal., deep-water harbor on Pacific coast between, examination for	394					
Duncan Falls, Ohio, bridge obstructing Muskingum River at	434					
Dunkirk Harbor, N. Y., improvement of	374				2878	
Duties of officers of Corps of Engineers, statement showing	453					
Duwamish River, Wash., examination of	409				3257	
Duwamish River, Wash., near Seattle, bridging	431					
D'Wamish River, Wash., examination of	409				3257	
D'Wamish River, Wash., near Seattle, bridging	431					
E.						
Eagle Harbor, Mich., improvement of	315			2505		
East Chester Creek, N. Y., improvement of	75 806					
East Omaha, Nebr., bridging Missouri River at	431					
East River, N. Y., establishment of harbor lines in	425 963					
East River, N. Y., removing obstructions from	86 899					
East Tennessee, Virginia and Georgia Railway bridge and Rome, Ga., Coosa River between, improvement of	208		1745			
East Tennessee, Virginia and Georgia Railway bridge and Wetumpka, Ala., Coosa River between, improvement of	208		1748			
East Tennessee, Virginia and Georgia Railway Company, bridge of, obstructing Tennessee River	435					
Eastern Branch of Elizabeth River and Lynn Haven Bay, Va., water way between, examination of	153	1310				
Eastern Branch of Potomac River, D. C., examination and survey of	146					
Eastern Branch of Potomac River, D. C., improvement of	135	1246				
Echo Harbor, New Rochelle, N. Y., improvement of	74 802					
Edgartown, Mass., Marthas Vineyard, inner harbor at, improvement of	49 698					
Edinburg and Carthage, Miss., Pearl River between, improvement of	220		1799			
Edisto River, S. C., improvement of	177	1480				
Edward J. Gay (steamboat), removal of wreck of	231		1809			
Effingham County, Ga., bridging Savannah River in	429					
Eldorado Canyon and Yuma, Ariz., Colorado River between, examination of	393				2974	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Elizabeth River, N. J., improvement of	100	993				
Elizabeth River, Va., Eastern Branch of, and Lynn Haven Bay, Va., water way between, examination of	153	1310				
Elizabeth River, Va., Western Branch of, examination of	153	1307				
Elizabethport, N. J., removal of wreck at	107	1013				
Elk River, Md., improvement of	125	1184				
Elk River, W. Va., examination for improvement of, by locks and dams	303			2433		
Elk River, W. Va., improvement of	300			2427		
Elk River, W. Va., obstructions in						3867
Ellen, Mary (schooner), removal of wreck of		1201				
Engineer Depot	16 547					
Engineer Divisions	19					
Engineer School, United States	15 539					
Engineers, Battalion of	15 540					
Engineers, Chief of, office of the	451					
Engineers, Corps of, laws of Fifty-first Congress, second session, affecting	477					
Engineers, Corps of, officers of	3					
Engineers, Corps of, recommendations as to examinations for promotion of officers of	4					
Engineers, Corps of, statement showing rank and duties of officers of	453					
Engineers, Division	19					
Engineers, The Board of	11					
Erie Harbor, Pa., improvement of	373				2860	
Erie Harbor, Pa., Presque Isle Peninsula, preservation and protection of	374				2877	
Escambia River, Fla., improvement of	203		1735			
Essex River, Mass., examination and survey of	47 676					
Evansville, Ind., and mouth of Green River, Ky., Ohio River between, examination of	294			2382		
Examinations and surveys	17					
Examinations for promotion of officers of Corps of Engineers, recommendations as to	4					
Examinations, surveys, and contingencies of rivers and harbors, estimates for	421					
Explorations	449					
Explosives, tests of	550 559					
F.						
Fairlee Creek, Md., improvement of	126	1186				
Fairport Harbor, Ohio, improvement of	371				2859	
Falia, Bogue, La., improvement of	222		1818			
Falls of Ohio River, Indiana Chute, improvement of	296			2393		
Falls of Ohio River, Louisville, Ky., improvement of	295			2387		
Falls of St. Anthony, Minn., Mississippi River above, improvement of	268			2192		
Farmer, Ky., and West Liberty, Licking River between, improvement of	306			2462		
Feather River, Cal., Board on improvement of	396				2990	
Feather River, Cal., improvement of	396				2987	
Feather River, Cal., investigation of mining-débris question	399				2996	
Fergus Falls, Minn., Red River of the North and tributaries above, examination and survey of	274					
Fernandina, Fla., and Savannah, Ga., inside route between, examination and survey of	185					
Fishing Creek, N. C., improvement of	150	1345				
Fishways at Great Falls, Potomac River, erection of	443					3905
Five Mile River Harbor, Conn., improvement of	72 792					
Flint River, Ga., improvement of	198		1698			
Florence, Ala., bridge obstructing Tennessee River at	435					
Florida Central and Peninsular Railroad Company, bridge of, obstructing Trout Creek, Fla	435					
Flushing Bay, N. Y., improvement of	77 822					
Fond du Lac, Minn., and Grassy Point, St. Louis River between, examination and survey of	317					
Forked Deer River, Tenn., improvement of	246			2012		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Forster, Frederick P., *et al.*, bridge of, in Barnstable, Mass	431					
Fort Benton, Mont., and Sioux City, Iowa, Missouri River between, examination and survey of	277			2242		
Fort Marion, Fla., repair and preservation of	6 11 533					
Fort Monroe, Va., beach protection, water supply, and sewerage system at	10 529					
Fort Niagara, N. Y., protection of site of	8 517					
Fortifications	4					
Fortifications, estimates of appropriations for 1892–'93	11					
Fortifications, protection, preservation, and repair of	6					
Fortifications, sites for	5					
Fourche River, Ark., improvement of	251			2044		
Fox River, Wis., improvement of	328			2572		
Fox River, Wis., operating and care of locks and dams on	329			2580		
Francis E. Hallock (schooner), removal of wreck of	93 937					
Frankfort Harbor, Mich., improvement of	337				2674	
Frankfort, Ky., bridge obstructing Kentucky River at	436					
Franklin, Ala., and West Point, Ga., Chattahoochee River between, examination of	211		1756			
French Broad River, Tenn., improvement of	280			2261		
Fulton, Ark., Red River above, improvement of	237			1961		
Fulton County, Ky., and Lake County, Tenn., Mississippi River between, examination of	258			2073		
Fulton, Miss., and Vienna, Ala., Tombigbee River between, improvement of	213		1780			
Fulton, Miss., and Walker Bridge, Miss., Tombigbee River between, improvement of	213		1779			
G.						
Galleries, cable, construction of	6					
Galveston Bay, Tex., ship channel in, improvement of	232		1906			
Galveston Bay, Tex., valuation of channel constructed by Buffalo Bayou Ship Channel Company in	233		1906 1910			
Galveston Harbor, Tex., entrance to, improvement of	231		1871			
Galveston (West) Bay, Tex., from Christians Point, for reopening channel through West Bay, examination and survey of	235					
Gartside, Benjamin (schooner), removal of wreck of	61 731					
Gasconade River, Mo., improvement of	261			2112		
Gauging Columbia River, Oregon and Wash.	419				3372	
Gauging Mississippi River and its principal tributaries	246			2014		
Gauging Mississippi River at or near St. Paul, Minn	273			2214		
Gauley River, W. Va., improvement of	301			2428		
Gay, Edward J. (steamboat), removal of wreck of	231		1869			
Gay Head Light, removal of wreck near	61 732					
Gen. W. T. Sherman (schooner), removal of wreck of	118	1090				
General Lee (steamer), removal of wreck of	184		1602			
Georgetown Harbor, S. C., improvement of	168	1408				
Gilchrist, Leo (elevator), removal of wreck of	231		1869			
Glaises, Bayou des, La., from Atchafalaya River to Cottonport, examination of	230		1854			
Glen Cove Harbor, N. Y., improvement of	77 820					
Gloucester Harbor, Mass., improvement of	36 635					
Goat Island, Newport Harbor, R. I., examination of spit at south end of	62 736					
Golden Eagle (schooner), removal of wreck of	32 610					
Goose Rapids, Red River of the North, Minn. and N. Dak., examination for construction of lock and dam	274			2220		
Gordon Landing, Lake Champlain, Vt., breakwater at	385				2930	
Goshen Creek, N. J., examination and survey of	119	1110				
Governors Island, N. Y., sea walls at	6 9 524					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Gowanus Bay channel, New York Harbor, N. Y., examination of	93 937					
Gowanus Bay, N. Y., improvement of	89 914					
Grand Haven Harbor, Mich., improvement of	340				2092	
Grand Lake, La., course of Mermenton River through, examination and survey of	230		1858			
Grand Marais, Mich., harbor of refuge at, improvement of	316			2509		
Grand Marais, Minn., harbor at, improvement of	310			2484		
Grand Rapids, Mich., Grand River below, examination and survey of	345					
Grand River, Mich., below Grand Rapids, examination and survey of	345					
Grand River, Ohio, below Richmond, examination and survey of	373					
Grand Trunk Railway Company, bridge of, obstructing channel to Back Cove, Portland, Me	435					
Grass River, N. Y., improvement of	384				2926	
Grassy Point, Minn., and Fond du Lac, St. Louis River between, examination and survey of	317					
Grays Harbor and Bar, Wash., examination and survey of	411				3297	
Grays Harbor, Wash., bridging Johns River near confluence with	430					
Grays River, Wash., examination and survey of	421				3385	
Great Bay, N. J., examination for harbor of refuge	118	1095				
Great Bay, N. J., north of Atlantic City and Cape May, thoroughfare between, examination of	118	1097				
Great Chazy River, N. Y., improvement of	385				2929	
Great Egg Harbor Bay and Barnegat Bay, N. J., sound between, examination of	118	1093				
Great Falls, Mont., and canyon next below Stubbs Ferry, Missouri River between, examination and survey of	278					
Great Falls, Mont., and Sioux City, Iowa, Missouri River between, improvement of	275			2232		
Great Falls, Potomac River, erection of fishways at	443					3905
Great Kanawha River, W. Va., at Charleston, bridging	429					
Great Kanawha River, W. Va., deposit of refuse in						3866
Great Kanawha River, W. Va., improvement of	299			2413		
Great Kanawha River, W. Va., operating and care of locks and dams on	300			2425		
Great Lakes, printing and distribution of charts of	445					3927
Great Lakes, ship channel in connecting waters of the, between Chicago, Duluth, and Buffalo, examination of	362				2810	
Great Lakes, survey of	445					3027
Great Pedee River, S. C., improvement of	172	1450				
Great Sodus Bay, N. Y., harbor at, improvement of	380				2900	
Great Wicomico River, Va., examination of	146	1288				
Green Bay Harbor, Wis., improvement of	320			2533		
Green Jacket Shoal, Providence River, R. I., removal of	55 715					
Green, Maria (schooner), removal of wreck of	131	1201				
Green River, Ky., above mouth of Big Barren River, examination of	310			2478		
Green River, Ky. (below Lock No. 1), at Spottsville, bridge obstructing	434					
Green River, Ky., mouth of, and Evansville, Ind., Ohio River between, examination of	294			2382		
Green River, Ky., operating and keeping in repair locks and dams on	304			2439		
Greenbrier River, W. Va., and Wilson Creek, Va., New River between mouths of, improvement of	302			2430		
Greenport Harbor, N. Y., improvement of	75 811					
Greenwich Bay, R. I., improvement of	53 716					
Grosse Pointe Channel, Mich., improvement of	359				2799	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Grounds, public, D. C., improvement and care of	444					3907
Gunter Creek at Guntersville, Ala., examination of	288			2325		
Guntersville, Ala., Gunter Creek at, examination of	288			2325		
Guyandotte River, W. Va., improvement of	308			2489		
H.						
Habersham (steamer), removal of wreck of	184		1002			
Hackensack, N. J., and Newark Bay, Hackensack River between, examination and survey of	107	1016				
Hackensack River, N. J., examination and survey of	107	1016				
Half-Moon Reef, Aransas Bay, Tex., examination for removal of	235		1942			
Hallock, Francis E. (schooner), removal of wreck of	93 937					
Hamilton, Ill.; slough in Mississippi River at, examination of	267			2185		
Hampton Creek and Bar, Va., improvement of	148	1297				
Hampton Roads, Va., construction of casemate at	6					
Hampton Roads, Va., defense of	5 8					
Handkerchief light-ship, removal of wreck near	61 781					
Harbor and river improvements	17					
Harbor lines, establishment of	18 423					
At Duluth, Minn., St. Louis Bay, Superior Bay, and adjacent waters, Minn. and Wis	18 426			2515		
At Lubec, Me	18 424 621					
At New Castle, Del	18 425	1225				
At San Pedro, Wilmington Harbor, Cal	18 426				2976	
In Astoria Harbor, Oregon	18 427				3387	
In Boston Harbor, Mass	18 424 688					
In Chicago Harbor, Ill	18 426			2661		
In Humboldt Bay, Cal	18 427				3138	
In Kennebec River at Bath, Me	18 424 622					
In New York Harbor and adjacent waters	18 424 958					
In port of Philadelphia, Pa	18 425	1121				
In Portage Lake, Mich	18 316 / 317 426			2519		
In St. Augustine Harbor, Fla	18 425		1685			
In San Francisco Harbor and adjacent waters, Cal	18 426				2948	
Harbor lines in Portage Lake, Mich., resurvey and relocation of	316 317			2522		
Harbors and rivers, examinations, surveys, and contingencies of, estimates for	421					
Harbors of refuge:						
At Block Island, R. I	59 723					
At entrance of Sturgeon Bay Canal, Wis	321			2536		
At Grand Marais, Mich	316			2509		
At Hyannis, Mass	48 694					
At Little Harbor, N. H	31 608					
At Lynnhaven Bay, Va., examination and survey for	146					
At Milwaukee Bay, Wis	325			2553		
At Nantucket, Mass	48 696					
At Point Judith, R. I	58 722					
At Portage Lake, Mich	337				2676	
At Sand Beach, Lake Huron, Mich	353				2776	
At Sandy Bay, Cape Ann, Mass	36 632					
At Stonington, Conn	60 728					
Near mouth of Delaware Bay, examination for	119	1120				
Harlem River, N. Y., at 155th street and McComb Dam Road, New York City, bridging	432					
Harlem River, N. Y., improvement of	84 886					
Harlowe River, N. C., improvement of		1363				
Harmar, Ohio, bridge obstructing Muskingum River at	434					
Harraseeket River, Me., improvement of	26 594					
Hartford, Conn., Connecticut River above, improvement of	64 748					
Hartford, Conn., Connecticut River below, examination of	79 80 836					
Hartford, Conn., Connecticut River below, improvement of	65 750					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Havre de Grace, Md., Susquehanna River above and below, improvement of	124	1181				
Havre de Grace, Md., Susquehanna River above, examination and survey of	132					
Hay Lake Channel, St. Marys River, Mich., improvement of	347				2758	
Hell Gate and East River, N. Y., removing obstructions from	86 899					
Herr Island Dam, Allegheny River, Pa., construction of	293-			2266		
Hiawassee River, Tenn., improvement of	280			2250		
Hingham Harbor, Mass., improvement of	12		1656			
Holland Harbor, Mich., improvement of	341				2696	
Holly Landing and Long Bridge, Va., Chickahominy River between, examination of	153	1305				
Holmes River, Fla., improvement of	200		1704			
Houma, La., and Thibodeaux, Bayou Terre Bonne between, examination of	229		1843			
Housatonic River, Conn., improvement of	69 773					
Houston, Central Arkansas and Northern Railroad Company, bridge of, across Little River, La	429	•				
Houston, Central Arkansas and Northern Railroad Company, bridge of, across Ouachita River, La	430					
Houston, Central Arkansas and Northern Railroad Company, bridge of, across Red River, La	430					
Hudson Harbor, Wis., examination of	274			2218		
Hudson River, N. Y., at Moodna River (Murderers Creek), Cornwall, examination and survey of	94 944					
Hudson River, N. Y., at New York City, bridging	433					3853
Hudson River, N. Y., Board on improvement of	82 866					
Hudson River, N. Y., improvement of	81 864					
Hudson River, N. Y., licenses for use of piers, etc., in						3865
Humboldt Bay, Cal., establishment of harbor lines in	18 427				3138	
Humboldt Harbor and Bay, Cal., improvement of	397				3120	
Huntington Bridge, Idaho, and Seven Devils Mining District, Upper Snake River between, examination and survey of	411				3285	
Huntington Harbor, N. Y., improvement of	76 817					
Huron Harbor, Ohio, improvement of	367				2843	
Huron, Lake, Corsica Shoal, Mich., at lower end of, examination of	363				2820	
Huron, Lake, harbor of refuge at Sand Beach, Mich	353				2776	
Hyannis, Mass., harbor of refuge at	48 604					
Hyannis, Mass., removal of wreck in harbor at	62 732					
I.						
Ice-harbors:						
At head of Delaware Bay, Del	113	1072				
At Marcus Hook, Pa	113	1072				
At mouth of Muskingum River, Ohio	293			2367		
At New Castle, Del	120	1160				
Illinois and Mississippi Canal, construction of	334			2633		
Illinois River, Ill.:						
Examination and survey of, below La Salle	335			2658		
Improvement of	332			2611		
Improvement of Mississippi River between Des Moines Rapids and	263			2119		
Improvement of Mississippi River between Ohio River and	259			2087		
Operating and care of La Grange Lock	333			2630		
Increasing water supply of Washington, D.C	442					3904
Indian River, Fla., between Titusville and Jupiter Inlet, examination of	195		1673			
Indiana Chute, Falls of Ohio River, improvement of	296			2093		
Injury to and occupancy of public works by corporations or individuals	19 436					3865
Inspection of improvement of South Pass of Mississippi River	19 221		1805			

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Inter-State Bridge and Street Railway Company, bridge of, across Missouri River at Council Bluffs, Iowa	431					
Ipswich River, Mass., improvement of	35 631					
Isle Marthe (ship), removal of wreck of	231		1869			
J.						
Jackson Creek, Chester River, Md., removal of wreck in	131	1201				
Jackson, Miss., and Carthage, Miss., Pearl River between, improvement of	220		1797			
Jackson, Miss., Pearl River below, improvement of	219		1795			
Jacksonville and Sanford, Fla., St. Johns River between, examination of	195		1666			
Jamaica Bay and Long Beach Inlet, N. Y., water way between, examination and survey of	94					
James River, Va., improvement of	134	1234				
Jefferson, Tex., and Shreveport, La., Cypress Bayou and the lakes between, survey of	248			2021		
Jekyl Creek, Ga., improvement of	183		1556			
Jellico Creek, Ky., Cumberland River above mouth of, improvement of	284			2275		
Johns River, Wash., near confluence with Grays Harbor, bridging	430					
Jones Landing, Md., and Crumpton, Chester River between, improvement of	126	1188				
Josiah Whitehouse (schooner), removal of wreck of	61 732					
Jupiter Inlet and Titusville, Fla., Indian River between, examination of	195		1673			
K.						
Kansas City, bridging Missouri River about 8.6 miles above	430					
Kansas City Terminal Railway Company, bridge of, across Missouri River near Quindaro, Kans	430					
Kansas River, Kans., bridging Missouri River near mouth of	432					
Karquines Strait, Cal., modification of harbor lines on south shore of	426				2948	
Karquines Strait, Cal., survey of	389				2947	
Kaskaskia River, Ill., improvement of	203			2118		
Kennebec River, Me., at Bath, establishment of harbor lines in	18 424 622					
Kennebec River, Me., from Waterville to Augusta, examination and survey of	33					
Kennebec River, Me., improvement of	26 590					
Kennebunk River, Me., improvement of	29 601					
Kenosha Harbor, Wis., improvement of	326			2565		
Kentucky River, Ky., at Frankfort, bridge obstructing	436					
Kentucky River, Ky., improvement of	305			2449		
Kentucky River, Ky., operating and keeping in repair locks and dams on	306			2455		
Kewaunee Harbor, Wis., improvement of	322			2540		
Keweenaw Bay and Portage Lake, Mich., purchase of canal between	17					
Keweenaw Point, Mich., purchase of canals across	17					
Key West Harbor, Fla., northwest entrance, improvement of	188		1640			
Keyport Harbor, N. J., improvement of	104	1001				
Kingston Harbor, Mass., examination and survey of	47 685					
Kingstree, S. C., Black River below, examination of	170	1435				
Klaskuine River, Wash., improvement of	419				3371	
L.						
La Fayette, Ind., and Terre Haute, Wabash River between, examination of	293			2411		
La Fourche, Bayou, La., improvement of	224		1621			
La Grange Bayou, Fla., improvement of	200		1704			
La Grange Lock, Illinois River, Ill., operating and care of	333			2030		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Lake Arthur, La., course of Mermenton River through, examination and survey of.	230		1658			
Lake Champlain, Narrows of, N. Y. and Vt., improvement of	387				2037	
Lake County, Tenn., and Fulton County, Ky., Mississippi River between, examination of	258			2073		
Lake des Allemands, La., and points near Vacherie, etc., bayous Chevreuil and Tigre between, examination of	229		1841			
Lake Huron, Corsica Shoal, Mich., at lower end of, examination of	363				2830	
Lake Huron, harbor of refuge at Sand Beach, Mich	353				2776	
Lake Monroe, Fla., St. Johns River above, examination of	195		1666			
Lake Pontchartrain, La., shoals in, near Rigolets, examination of	229		1839			
Lake Samamish, Wash., ship canal to connect Puget Sound with, examination for	412					
Lake Superior, purchase of canals connecting Portage Lake, Mich., with	17					
Lake Superior Ship Canal Railway and Iron Company Canal, purchase of	17					
Lake Union, Wash., ship canal to connect Puget Sound with, examination for	412					
Lake Washington, Wash., ship canal to connect Puget Sound with, examination for	412					
Lakes, Great, ship channel in connecting waters of the, between Chicago, Duluth, and Buffalo, examination of	362				2810	
Lakes, northern and northwestern, printing and distribution of charts of	445					3927
Lakes, northern and northwestern, survey of	445					3927
Larchmont Harbor, N. Y., improvement of	74 800					
La Salle, Ill., Illinois River below, examination and survey of	335			2058		
La Trappe River, Md., examination and survey of	132	1215				
Laws of Fifty-first Congress, second session, affecting Corps of Engineers	477					
Leaf River, Miss., improvement of	218		1793			
Leavenworth and Platte County Bridge Company, bridge of, across Missouri River at Leavenworth, Kans	428					
Leavenworth, Kans., bridging Missouri River at	428					
Leavenworth, Kans., Missouri River from old mouth of Platte River, Little Point, to a point opposite, examination of	275			2229		
Lee, General (steamer), removal of wreck of.	184		1602			
Lee Slough, Fla., improvement of	197		1696			
Leo Gilchrist (elevator), removal of wreck of.	231		1869			
Levisa Fork, Big Sandy River, Ky., improvement of	307			2468		
Lewes, Del., construction of iron pier in Delaware Bay near	114	1073				
Lewes, Del., Delaware Bay at or near, and Chincoteague Bay, Va., water way between, improvement of	123	1168				
Lewis and Clarke River, Oregon, examination and survey for snagging	421				3383	
Lewiston, Idaho, bridging Clearwater River about 11 miles above	431					
Licking River, Ky., between Farmer and West Liberty, improvement of	306			2462		
Linchester River, Md., examination of	131	1202				
Little Egg Harbor Bay and Inlet, N. J., examination for harbor of refuge at	118	1095				
Little Harbor, N. H., harbor of refuge at	31 608					
Little Island, Mass., bridging channel between mainland at Osterville and, Barnstable, Mass	431					
Little Kanawha River, W. Va., improvement of	308			2471		
Little Narragansett Bay, Watch Hill Cove, R. I., examination of	62 735					
Little Pedee River, S. C., improvement of	171	1448				
Little Pigeon River, Tenn., below Sevierville, examination of	285			2287		
Little Platte River, Mo., old mouth of, to a point opposite Leavenworth, Missouri River from, examination of	275			2229		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Little Point, Missouri River from old mouth of Platte River at, to a point opposite Leavenworth, examination of	275			2229		
Little Red River, Ark., improvement of	254			2053		
Little River, La., bridging	429					
Little River, Mo. and Ark., improvement of	256			2094		
Little Rock Island, Mississippi River, near Clinton, Iowa, examination and survey for removal of bars north of	267			2187		
Little Sodus Bay, N. Y., harbor at, improvement of	380				2900	
Little Tennessee River, near Niles Ferry, Tenn., bridge obstructing	435					
Locks and dams:						
Coosa River, Ga. and Ala., operating and care of locks and dams, etc., on	210		1753			
Fox River, Wis., operating and care of locks and dams on	329			2580		
Great Kanawha River, W. Va., operating and care of locks and dams on	300			2425		
Green and Barren rivers, Ky., operating and keeping in repair locks and dams on	304			2439		
Illinois River, Ill., operating and care of La Grange Lock	333			2630		
Kentucky River, Ky., operating and keeping in repair locks and dams on	306			2455		
Monongahela River, operating and care of locks and dams Nos. 8 and 9	291			2357		
Monongahela River, purchase of Lock and Dam No. 7	291			2359		
Monongahela River, purchase of Lock and Dam No. 6	291			2360		
Muskingum River, Ohio, operating and care of locks and dams on	293			2369		
Lockwood's Folly River, N. C., improvement of	167	1402				
Long Beach Inlet and Jamaica Bay, N. Y., water way between, examination and survey of	94					
Long Bridge and Holly Landing, Va., Chickahominy River between, examination of	153	1305				
Louisville and Nashville Railroad Company, bridge of, obstructing Kentucky River, Ky	436					
Louisville and Portland Canal, Ky., operating and care of	296			2394		
Louisville, Ky., Falls of Ohio River at, improvement of	295			2387		
Louisville, St. Louis and Texas Railroad Company, bridge of, obstructing Green River, Ky	434					
Lower Willamette River, Oregon, below Portland, improvement of	416				3362	
Lubec Channel, Me., examination of	33 616					
Lubec Channel, Me., improvement of	19 571					
Lubec, Me., establishment of harbor lines at	18 424 621					
Ludington Harbor, Mich., improvement of	338				2032	
Lumber River, N. C. and S. C., improvement of	171	1445				
Lynn Harbor, Mass., improvement of	39 641					
Lynn Haven Bay and eastern branch of Elizabeth River, Va., water way between, examination of	153	1310				
Lynn Haven Bay, near Cape Henry, at foot of Chesapeake Bay, Va., examination and survey for harbor of refuge at	146					
M.						
Machodoc Creek, Upper, Va., examination of	146	1286				
Mackey Creek, N. C., improvement of	155	1339				
Maçon, Bayou, La., improvement of	241			1983		
Macon, Dublin and Savannah Railroad Company, bridge of, across Oconee River, Ga	430					
Malden River, Mass., examination of	47 672					
Manasquan (Squan) River, N. J., improvement of	106	1010				
Manatee River, Fla., improvement of	191		1653			
Manchac, Bayou, La., improvement of	223		1820			
Manchester Harbor, Mass., improvement of	37 638					
Manisteo Harbor, Mich., improvement of	338				2078	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Manistique Harbor, Mich., improvement of.	317			2523		
Manitowoc Harbor, Wis., improvement of..	323			2515		
Manokin River, Md., improvement of	129	1195				
Maps, estimates for publication of.....	450					
Maps, military and other.....	449					
Marcus Hook, Pa., ice-harbor at, improvement of	113	1072				
Maria Green (schooner), removal of wreck of.	131	1201				
Marietta and North Georgia Railway Company, bridge of, obstructing Little Tennessee River	435					
Marietta, Ohio, bridge obstructing Muskingum River at	434					
Marion, Fort, Fla., repair and preservation of.....	6 11 533					
Marquette Harbor, Mich., improvement of..	315			2505		
Marquette Harbor, Mich., survey at.....	445					3227
Marthas Vineyard, inner harbor at Edgartown, Mass., improvement of	49 698					
Marthas Vineyard, Menemsha Bight, Mass., examination and survey of.....	62					
Mary Ellen (schooner), removal of wreck of.		1201				
Mary H. Rhoades (schooner), removal of wreck of.....	131	1201				
Mattaponi River, Va., improvement of	144	1273				
Mattawan Creek, N. J., improvement of....	104	1003				
Mattituck Bay, Suffolk County, N. Y., examination for breakwater at.....	80 843					
Maurice River, N. J., improvement of.....	117	1088				
May, Cape. (*See* Cape May.)						
McComb Dam Bridge, New York, N. Y., bridge to replace	432					
McKeesport, Pa., bridging Youghiogheny River at	431					
McMinnville, Oregon, Yamhill River below, examination and survey of.....	421				3361	
Mediator (steamer), removal of wreck of....	118	1090				
Memphis Harbor, Tenn., examination of....	258					3587
Menemsha Bight, Marthas Vineyard, Mass., examination and survey of.....	62					
Menomonee Harbor, Mich. and Wis., improvement of.....	318			2527		
Menomonee River, Mich. and Wis., improvement of	318			2528		
Mermenton River, La., and tributaries, examination and survey of	230		1858			
Merrimac River, Mass., improvement of....	34 628					
M. E. Tremble (schooner), removal of wreck of.....	361				2801	
Mianus River, Conn., examination and survey of	81 852					
Michigan City Harbor, Ind., improvement of.	344				2706	
Miles City, Mont., Tongue River near, examination of.....	277			2237		
Milford Harbor, Conn., improvement of.....	69 770					
Military departments, estimates for surveys and reconnaissances in.....	450					
Military divisions and departments, reconnaissances and explorations in.....	449					3943
Military maps	449					
Milwaukee Bay, Wis., harbor of refuge at ..	325			2553		
Milwaukee Harbor, Wis., improvement of..	325			2560		
Mingo Creek, S. C., improvement of.....	173	1455				
Mining-débris question in California, investigation of.....	399				2996	
Minneapolis, Minn., and Des Moines Rapids, Mississippi River between, improvement of.....	265			2147		
Minnesota Point, at Superior, Wis., improvement of	313			2499		
Minnesota River, Minn., improvement of....	271			2207		
Minnewaukon Shoals, Devil Lake, N. Dak., examination of.....	274			2223		
Mispillion Creek, Del., improvement of	122	1166				
Mispillion River, Del., examination and survey of	132					
Mississippi Canal, Illinois and, construction of.....	334			2033		
Mississippi River:						
Bridging, at Alton, Ill	432					
Bridging, at St. Paul, Minn	430					
Bridging, at Winona, Minn	427 431					
Bridging, near Clinton, Iowa.....	428					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Mississippi River—Continued.						
Examination and survey for removal of bars north of Little Rock Island, near Clinton, Iowa	267			2187		
Examination and survey to determine effect of back water at Clarendon, Ark., and Lower White River	257					
Examination of, at Memphis Harbor, Tenn	258					3587
Examination of, at Warsaw, Ill	264			2134		
Examination of, from Lake County, Tenn., to Fulton County, Ky., north and west of Reelfoot Lake	258			2073		
Examination of slough at Hamilton, Ill	267			2185		
Gauging, and its principal tributaries	246			2014		
Gauging, at or near St. Paul, Minn	273			2214		
Improvement of, above Falls of St. Anthony, Minn	268			2192		
Improvement of, between Des Moines Rapids and Illinois River	263			2119		
Improvement of, between Minneapolis and Des Moines Rapids	265			2147		
Improvement of, between Ohio and Illinois rivers	259			2087		
Improvement of Des Moines Rapids	266			2172		
Improvement of, etc., between Ohio River and Head of the Passes (report of Mississippi River Commission)	422					3397
Inspection of improvement of South Pass of	19	221	1805			
Operating snag boats and dredge boats on Upper	264			2137		
Removing snags and wrecks from	258			2079		
Reopening Willow Slough, or some other channel from Quincy Bay to				2124		
Reservoirs at headwaters of	268			2196		
Survey for reservoirs at sources of				2214		
Mississippi River Commission, report of	422					3397
Missouri, Division of the, report of engineer officer on operations in	449					3943
Missouri River:						
Bridging, between Council Bluffs, Iowa, and East Omaha, Nebr	431					
Bridging, between Leavenworth, Kans., and Platte County, Mo	428					
Bridging, near mouth of Kansas River, between Wyandotte County, Kans., and Clay County, Mo	432					
Bridging, near Quindaro, Kans., about 8.6 miles above Kansas City	430					
Examination and survey of, between canyon next below Stubbs Ferry and Great Falls, Mont	278					
Examination and survey of, between mouth of Big Sioux River and north line of South Dakota	277			2242		
Examination and survey of, between Sioux City, Iowa, and Fort Benton, Mont	277			2242		
Examination of, at Weston, Mo	275			2229		
Examination of, from old mouth of Platte River, Little Point, to point opposite Leavenworth, Kans	275			2229		
Improvement of, between Great Falls, Mont., and Sioux City, Iowa	275			2232		
Improvement of, etc. (report of Missouri River Commission)	423					3723
Missouri River and Land Improvement and Construction Company, bridge of, across Missouri River near mouth of Kansas River	432					
Missouri River Commission, report of	423					3723
Mobile Harbor, Ala., improvement of	211		1771			
Mokelumne River, Cal., examination and survey of	399				3133	
Mokelumne River, Cal., improvement of	395				2986	
Monongahela River, W. Va. and Pa.:						
Bridging, near Pittsburg	432					
Improvement of	290			2355		
Operating and care of Locks and Dams Nos. 8 and 9	291			2357		
Purchase of Lock and Dam No. 7	291			2359		
Purchase of Lock and Dam No. 6	291			2360		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Monroe, Fort, Va., beach protection, water supply, and sewerage system at	10 529					
Monroe Harbor, Mich., improvement of	363				2825	
Monroe, Lake, Fla., St. Johns River above, examination of	195		1666			
Montesano, Wash., Chehalis River below, examination and survey of	411				3297	
Monument, Washington, Washington, D. C., maintenance of	444					3977
Moodna River, N. Y., examination and survey of	24 944					
Mooseabec Bar, Me., improvement of	20 572					
Mount Desert to Porcupine Island, Me., breakwater from	21 576					
Mount Vernon, Va., Potomac River at, improvement of	138	1252				
Moyock, N. C., North-West River below, examination of	153	1321				
Murderers Creek, N. Y., examination and survey of	24 944					
Murderkill River, Del., examination and survey of	132					
Murphy, John H., *et al.*, bridge of, in Barnstable, Mass	431					
Muscle Shoals Canal, Tennessee River, operating and care of	287			2222		
Muskegon Harbor, Mich., improvement of	340				2689	
Muskingum County, Ohio, bridges of commissioners of, obstructing Muskingum River	434					
Muskingum River, Ohio:						
Bridge obstructing, between Marietta and Harmar	434					
Bridge obstructing, between Taylorsville and Duncan Falls	434					
Bridge obstructing canal of, at foot of Main street, Zanesville	434					
Ice-harbor at mouth of	293			2367		
Improvement of	293			2369		
Operating and care of locks and dams on	293			2369		
Myrtle Point, Oregon, and Coquille City, Coquille River between, examination and survey of	410				3275	
Mystic River, Conn., improvement of	63 740					
Mystic River, Mass., examination and survey of	47 672					
N.						
Nandua Creek, Va., examination of	146	1283				
Nansemond River, Va., improvement of	148	1298				
Nanticoke River, Md., northwest fork of, examination of	131	1204				
Nantucket, Mass., harbor of refuge at	48 696					
Napa River, Cal., improvement of	389				2952	
Narragansett Bay, R. I., channel between Starve Goat Island and mainland, examination of	62 733					
Narragansett Bay, R. I., construction of casemates for defense of	6					
Narragansett Bay, R. I., improvement of	54 712					
Narraguagus River, Me., improvement of	21 574					
Narrows of Lake Champlain, N. Y. and Vt., improvement of	387				2937	
Nasel River, Wash., examination and survey of	411				3294	
Nashville (steamer), wreck of			1605			
Nashville, Tenn., Cumberland River above, improvement of	283			2270		
Nashville, Tenn., Cumberland River below, improvement of	282			2208		
Neches River, Tex., improvement of	228		1836			
Nehalem Bay, Oregon, improvement of	405				3205	
Nellie (barge), removal of wreck of	107	1013				
Nemadji River, at Superior, Wis., examination of	316			2512		
Neshawana and Cuttyhunk islands, Mass., Canapitsit Channel, between, examination and survey of	62					
Neuse River, N. C., improvement of	159	1358				
New Bedford Harbor, Mass., improvement of	51 704					

Digitized by Google

Subject.	Page. Part I.		Part II.	Part III.	Part IV.	Part V.	Part VI.
New Berne and Beaufort, N. C., water way between, improvement of	160		1363				
New Bridge Company, bridge of, obstructing Ashley River, S. C	433						
New Castle, Del., establishment of harbor lines at	18	425	1225				
New Castle, Del., ice-harbor at, improvement of	120		1160				
New Haven, Conn., breakwater at	68	766					
New Haven Harbor, Conn., improvement of	67	761					
New London Harbor, Conn., examination of Shaw Cove	79	833					
New London Harbor, Conn., improvement of	64	746					
New Orleans Harbor, La., removal of wrecks in	231			1869			
New River, N. C., and Beaufort Harbor, N. C., water way between, improvement of	162		1372				
New River, N. C., and Swansboro, N. C., water way between, improvement of	162		1376				
New River, N. C., improvement of	163		1379				
New River, Va. and W. Va., improvement of	302				2430		
New Rochelle Harbor, N. Y., improvement of	74	804					
New Rochelle, N. Y., Echo Harbor, improvement of	74	802					
New York Central and Hudson River Railroad Company, bridge of, obstructing Spuyten Duyvil Creek, N. Y	435						
New York Harbor, N. Y.:							
Construction of casemates at	6						
Defense of	5	7					
Establishment of harbor lines in, and adjacent waters	18	424, 958					
Examination of Bay Ridge Channel	94	940					
Examination of Buttermilk and Gowanus Bay channels	93	937					
Improvement of	90	922					
Improvement of Bay Ridge Channel	90	917					
Improvement of Buttermilk Channel	88	911					
Improvement of Gowanus Bay	89	914					
Removal of wreck in	93	937					
Supervision of	422					3393	
New York, N. Y., bridge of commissioners of public parks of city of, across Harlem River at 155th street and McComb Dam Road	432						
New York, N. Y., bridging Hudson River at	433						3853
Newark Bay, N. J., and Hackensack, N. J., Hackensack River between, examination and survey of	107		1016				
Newark, N. J., Passaic River above, improvement of	100		990				
Newark, N. J., Passaic River below, improvement of	99		988				
Newburyport Harbor, Mass., improvement of	33	626					
Newport Creek, head of Wicomico River, Md., examination of	146		1281				
Newport Harbor, R. I., improvement of	57	719					
Newport Harbor, R. I., south of Goat Island, examination of	62	736					
Newport River, N. C., improvement of			1363				
Newtown Creek, N. Y., establishment of harbor lines in	424	961					
Newtown Creek, N. Y., improvement of	87	906					
Niagara Falls, N. Y., Port Day above, examination and survey of	378						
Niagara, Fort, N. Y., protection of site of	8	517					
Niagara River, N. Y., improvement of	376					2888	
Niles Ferry, Tenn., bridge obstructing Little Tennessee River near	435						
Nomini Creek, Va., improvement of	140		1259				
Nooksack River, Wash., examination of	410					3271	
Nootsack River, Wash., improvement of	408					3238	
Norfolk and Western Railroad Company, bridges of, across Tug Fork of Big Sandy River	431						
Norfolk Harbor, Va., and Albemarle Sound, N. C., water way between, improvement of	151		1302				
Norfolk Harbor, Va., improvement of	146		1291				
Norfolk Harbor, Va., improvement of approaches to	146	147	1291	1296			

Digitized by Google

SUBJECT.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
North East (Cape Fear) River, N. C., improvement of	164	1383				
North East River, Md., improvement of	124	1182				
North Landing River, Va. and N. C., improvement of	151	1304				
North River Bar, N. C., improvement of	152	1305				
North River Bridge Company, bridge of, across Hudson River at New York City	433					3853
North River, Mass., at Salem, examination of	46 668					
North River, Mass., shoals at mouth of, examination of	46 670					
North River, Wash., examination and survey of	400				3263	
North-West River, N. C., below Moyock, examination of	153	1321				
Northern and northwestern lakes, printing and distribution of charts of	445					3927
Northern and northwestern lakes, ship channel in connecting waters of, between Chicago, Duluth, and Buffalo, examination of	362				2810	
Northern and northwestern lakes, survey of	445					3927
Northern Pacific and Puget Sound Shore Railroad Company, bridge of, across Duwamish River, Wash	431					
Northwestern and northern lakes, printing and distribution of charts of	445					3927
Northwestern and northern lakes, ship channel in connecting waters of, between Chicago, Duluth, and Buffalo, examination of	362				2810	
Northwestern and northern lakes, survey of	445					3927
Norwalk Harbor, Conn., improvement of	71 786					
Nottoway River, Va., below Courtland, examination of	153	1315				
Noxubee River, Miss., improvement of	217		1787			
O.						
Oak Bay and Port Townsend Bay, Puget Sound, Wash., examination for ship channel between	409				3260	
Oak Orchard Harbor, N. Y., improvement of	377				2896	
Oakland Harbor, Cal., improvement of	388				2943	
Obion River, Tenn., examination and survey of	285			2292		
Occoquan Creek, Va., improvement of	138	1253				
Occupancy of and injury to public works by corporations or individuals	19 436					3865
Ocklawaha River, Fla., improvement of	186		1620			
Ocmulgee River, Ga., improvement of	182		1543			
Ocmulgee River, Ga., to Covington, Yellow River from, examination of	184		1606			
Oconee River, Ga., improvement of	181		1536			
Oconee River, Ga., near Dublin, bridging	429 430					
Oconto Harbor, Wis., improvement of	319			2531		
Ocracoke Inlet, N. C., improvement of	156	1341				
Office of the Chief of Engineers	451					
Officers of Corps of Engineers	3					
Officers of Corps of Engineers, recommendations as to examinations for promotion of	4					
Officers of Corps of Engineers, statement showing rank and duties of	453					
Ogdensburg Harbor, N. Y., improvement of	383				2923	
Ogeechee River, Ga., wrecks in			1005			
Ohio River:						
Construction of movable dam near mouth of Beaver River, Pa	290			2354		
Examination of, at Owensboro, Ky	294			2380		
Examination of, between mouth of Green River, Ky., and Evansville, Ind	294			2382		
Improvement of	288			2328		
Improvement of Falls of, Louisville, Ky	295			2387		
Improvement of Indiana Chute, Falls of	296			2393		
Improvement of Mississippi River below, etc. (report of Mississippi River Commission)	422					3397
Improvement of Mississippi River between Illinois River and	259			2087		
Operating and care of Davis Island Dam	290			2350		
Operating snag boats on	290			2349		
Olcott Harbor, N. Y., improvement of	377				2893	
Olympia Harbor, Wash., examination and survey of	411					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Omaha, Nebr., bridging Missouri River at East	431					
Onancock Harbor, Va., improvement of	129	1197				
Ontonagon Harbor, Mich., improvement of	314			2502		
Oregon Railway Extensions Company, bridge of, across Columbia River near Vancouver, Wash	429					
Osage River, Mo., improvement of	262			2114		
Osterville, Barnstable, Mass., bridging channel between Little Island and mainland at	431					
Oswego Harbor, N. Y., improvement of	381				2912	
Otter Creek, Vt., improvement of	386				2935	
Ouachita River above Camden, Ark., improvement of	239			1975		
Ouachita River, Ark. and La., improvement of	238			1964		
Ouachita River, La., near Columbia, bridging	430					
Owensboro Harbor, Ky., Ohio River, examination of	294			2380		
P.						
Pacific coast, deep-water harbor between Points Duma and Capistrano, Cal., on, examination for	394					
Pacific, Division of the, report of acting engineer officer on operations in	450					3947
Paddy Ryan (scow), removal of wreck of		1090				
Padilla Bay, Wash., and Skagit Bay, water way through Swinomish Slough connecting, examination and survey of	411					
Pamlico River, N. C., and Bay River, N. C., water way between, examination of	170	1421				
Pamlico River, N. C., at Washington Harbor, examination of	170	1429				
Pamlico River, N. C., improvement of	157	1347				
Pamlico River, N. C., opposite Swan Point, removal of wreck in	169	1417				
Pamunkey River, Va., improvement of	145	1275				
Pascagoula River, Miss., improvement of	217		1788			
Pasquotank River, N. C., improvement of	155	1335				
Passaic River, N. J., above Newark, improvement of	100	990				
Passaic River, N. J., below Newark, improvement of	99	988				
Passaic River, N. J., improvement of	99	988				
Patapsco River, Md., from Craighill Channel to sugar refinery wharves, Curtis Bay, examination of	135	1243				
Patapsco River, Md., improvement of	132	1227				
Patchogue River, N. Y., improvement of	78 825					
Patuxent River, Md., improvement of	141	1262				
Pawcatuck River, R. I. and Conn., improvement of	60 726					
Pawtucket River, R. I., improvement of	54 709					
Peace River, Fla. (*See* Pease River.)						
Pearl River, Miss., below Jackson, improvement of	219		1795			
Pearl River, Miss., between Edinburg and Carthage, improvement of	220		1799			
Pearl River, Miss., between Jackson and Carthage, improvement of	220		1797			
Pease Creek, Fla., improvement of	190		1646			
Pease River, Fla., examination of	195		1678			
Peconic River, Suffolk County, N. Y., examination and survey of	81 855					
Penobscot River, Me., examination and survey of	33					
Penobscot River, Me., improvement of	23 579					
Pensacola Harbor, Fla., improvement of	202		1710			
Pensaukee Harbor, Wis., improvement of	319			2533		
Pensauken Creek, N. J., examination of	118	1100				
Pentwater Harbor, Mich., improvement of	339				2684	
Pepperell Cove, Me., examination of	32 614					
Petaluma Creek, Cal., improvement of	397				3119	
Petit Jean River, Ark., improvement of	252			2046		
Petoskey Harbor, Mich., improvement of	336				2670	
Philadelphia Harbor, Pa., construction of casemates at	6					
Philadelphia Harbor, Pa., improvement of	110	1029				
Philadelphia, Pa., establishment of harbor lines in port of	18 425	1121				

Digitized by Google

Subject.	Page. Part I.		Part II.	Part III.	Part IV.	Part V.	Part VI.
Pier in Delaware Bay, near Lewes, Del., construction of	114		1073				
Piers, etc., occupancy of and injury to, by corporations or individuals	19	436					3865
Pine Lake, Mich., entrance to, improvement of	336					2072	
Pine Lake, Mich., near Charlevoix, bridging	432						
Piscataway Creek, Md., examination of	145		1279				
Piscataway Creek, Va., examination of	146		1289				
Pittsburg, Pa., bridging Allegheny River at Sixth street	431						
Pittsburg, Pa., bridging Monongahela River near	432						
Plaquemine, Bayou, La., bridge obstructing	434						
Plaquemine, Bayou, La., improvement of	225			1824			
Plaquemine, Bayou, La., securing mouth of, from further caving	231			1867			
Platte County, Mo., bridging Missouri River at	428						
Platte, Department of the, report of acting engineer officer on operations in	450						3946
Platte River (Little), Mo., old mouth of, to a point opposite Leavenworth, Kans., Missouri River from, examination of	275				2329		
Plattsburg Harbor, N. Y., improvement of	385					2931	
Plattsburg, N. Y., inner bay near mouth of Saranac River at, examination of	388					2938	
Pleasant River, Me., improvement of	20	578					
Pleasant River, Me., removal of wrecks in	32	610					
Plymouth Harbor, Mass., improvement of	44	660					
Point Judith, R. I., harbor of refuge at	58	722					
Points Duma and Capistrano, Cal., deep-water harbor on Pacific coast between, examination for	394						
Pollock Rip Shoals, Mass., removal of wreck at	61	731					
Pontchartrain, Lake, La., shoals in, near Rigolets, examination of	229			1839			
Porcupine Island, Me., breakwater from Mount Desert to	21	576					
Port Barre, La., and St. Martinsville, Bayou Teche between, examination of	230			1852			
Port Chester Harbor, N. Y., improvement of	73	797					
Port Clinton Harbor, Ohio, improvement of	305					2835	
Port Costa, Cal., modification of harbor lines at	426					2948	
Port Day, N. Y., above Niagara Falls, examination and survey of	378						
Port Huron, Mich., Black River at, improvement of	354					2780	
Port Jefferson Inlet, harbor at, N. Y., improvement of	76	814					
Port Orford Harbor, Oregon, reëxamination of	411					3305	
Port Royal and Augusta Railway Company, bridge of, obstructing Savannah River, Ga	435						
Port Townsend Bay and Oak Bay, Puget Sound, Wash., examination for ship channel between	409					3260	
Port View Bridge Company, bridge of, across Youghiogheny River, Pa	431						
Port Washington Harbor, Wis., improvement of	324				2551		
Portage Lake and River Improvement Company Canal, purchase of	17						
Portage Lake, Mich., harbor of refuge at	337					2676	
Portage Lake, Mich. (Houghton County), establishment of harbor lines in	18	316					
	317	426			2519		
Portage Lake, Mich. (Houghton County), purchase of canals between, and Keweenaw Bay and Lake Superior, Mich	17						
Portage Lake, Mich. (Houghton County), resurvey and relocation of harbor line in	316	317			2522		
Portage River, Mich., purchase of water way along	17						
Portland Canal, Louisville and, Ky., operating and care of	206				2204		
Portland Harbor, Me., construction of casemate at	6						
Portland Harbor, Me., improvement of	27	595					
Portland Harbor, Me., removal of wreck from	32	609					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Portland, Me., bridge obstructing channel to Back Cove	435					
Portland, Me., improvement of channel in Back Cove	27 597					
Portland, Oregon, Columbia and Willamette rivers below, examination and survey of	421					
Portland, Oregon, Columbia and Willamette rivers below, improvement of	416				3302	
Portland, Oregon, Willamette River above, improvement of	417				3308	
Portsmouth Harbor, N. H., improvement of	30 604					
Post of Willets Point, N. Y.	15 537					
Potomac Creek, Va., examination of	146	1285				
Potomac River:						
Erection of fish ways at Great Falls	443					3305
Examination and survey of, below Washington, D. C	146					
Examination and survey of Eastern Branch of, D. C	146					
Improvement of, at Mount Vernon, Va	138	1252				
Improvement of, at Washington, D. C	135	1246				
Improvement of Eastern Branch of, D. C.	135	1246				
Powow River, Mass., bridge across	427					
Powow River, Mass., improvement of	35 630					
Presque Isle Peninsula, Erie Harbor, Pa., preservation and protection of	374				2877	
Priest Rapids, Wash., foot of, and head of Rock Island Rapids, Columbia River between, improvement of	406				3223	
Princess Bay, Staten Island, N. Y., examination of	107	1013				
Printing and distribution of charts of northern and northwestern lakes	445					3927
Promotion of officers of Corps of Engineers, recommendations as to examinations for	4					
Providence River, R. I., improvement of	54 712					
Providence River, R. I., removal of Green Jacket Shoal	55 715					
Provincetown Harbor, Mass., improvement of	45 665					
Public buildings and grounds, D. C., improvement and care of	444					3907
Public works, occupancy of and injury to, by corporations or individuals	19 436					3865
Publication of maps, estimates for	450					
Puget Sound, Wash., ship canal to connect Lakes Union, Washington, and Samamish with, examination for	412					
Puget Sound, Wash., ship channel between Port Townsend Bay and Oak Bay, examination for	409				3260	
Puget Sound, Wash., water way through Swinomish Slough connecting Saratoga Passage and Skagit Bay with Padilla Bay, examination and survey of	411					
Pultneyville Harbor, N. Y., improvement of	379				2903	
Pungo River to Sladesville, N. C., water way from, examination of	170	1418				
Puyallup River, Wash., examination of	409				3255	
Q.						
Quincy Bay, Ill., reopening Willow Slough, or some other channel, from Mississippi River to				2124		
Quindaro, Kans., bridging Missouri River near	430					
R.						
Racine Harbor, Wis., improvement of	326			2562		
Rahway River, N. J., improvement of	101	906				
Rancocas River, N. J., improvement of	116	1084				
Rancocas River, N. J., removal of wreck in		1090				
Rank and duties of officers of Corps of Engineers, statement showing	453					
Rappahannock River, Va., improvement of	142	1264				
Raritan Bay, N. J., improvement of	92 931					
Raritan Bay, N. J., removal of wreck in	93 937					
Raritan River, N. J., establishment of harbor lines in	424 960					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Raritan River, N. J., improvement of	102	996				
Reconnaissances	449					
Reconnaissances in military departments, estimates for	450					
Red River above Fulton, Ark., improvement of	237			1961		
Red River, La. and Ark., improvement of	236			1946		
Red River, La., at Upper Falls, near Alexandria, bridging	430					
Red River of the North, Minn. and N. Dak., and tributaries above Fergus Falls and Crookston, and Big Stone Lake, examination and survey of	274					
Red River of the North, Minn. and N. Dak., at Goose Rapids, examination for construction of lock and dam	274			2220		
Red River of the North, Minn. and N. Dak., improvement of	272			2210		
Redondo Beach Harbor, Cal., examination of	393				2372	
Redwood Creek, Cal., examination of	393				2966	
Redwood Creek, Cal., improvement of	390				2953	
Redwood Harbor, Cal., improvement of	390				2953	
Reelfoot Lake, Tenn., Mississippi River north and west of, examination of	258			2073		
Reservoirs at headwaters of Mississippi River	268			2196		
Reservoirs at sources of Mississippi, St. Croix, Chippewa, and Wisconsin rivers, surveys for				2214		
Rhoades, Mary H. (schooner), removal of wreck of	131	1201				
Richmond, Ohio, Grand River below, examination and survey of	373					
River and harbor improvements	17					
Rivers and harbors, examinations, surveys, and contingencies of, estimates for	421					
Roads in Yellowstone National Park, construction and improvement of	447					3931
Roanoke River, Va. and N. C., improvement of	154	1330				
Roberts Landing and Collins Crossing, N. C., White Oak River between, examination of	170	1434				
Rock Hall Harbor, Md., examination and survey of	132					
Rock Island Rapids, Wash., head of, and foot of Priest Rapids, Columbia River between, improvement of	406				3223	
Rockland Harbor, Me., improvement of	25 589					
Rockport Harbor, Me., improvement of	25 588					
Rome, Ga., and East Tennessee, Virginia and Georgia Railroad bridge, Coosa River between, improvement of	208		1745			
Rondeway, Bayou, La., improvement of	242			1902		
Rondout Harbor, N. Y., improvement of	83 882					
Ross Island, Oregon, Willamette River at examination and survey of	421					
Rouge River, Mich., examination for turning basin in	363				2822	
Rouge River, Mich., improvement of	360				2791	
Rough River, Ky., improvement of	305			2446		
Rouse Point, Lake Champlain, N. Y., breakwater at	384				2927	
Russel Fork of Big Sandy River, Ky., examination of	310			2476		
Russell, Annie J. (schooner), removal of wreck of	32 609					
Ryan, Paddy (scow), removal of wreck of		1090				
S.						
Sabine Lake, La. and Tex., and Calcasieu Lake, connection between, via Bayou Black, examination of	230		1850			
Sabine Lake, La. and Tex., and Sudduth Bluff, Sabine River between, examination of	230					
Sabine Pass, Tex., harbor at, improvement of	227		1831			
Sabine River, Tex., between Sabine Lake and Sudduth Bluff, examination of	230					
Sabine River, Tex., improvement of	228		1835			
Sacketts Harbor, N. Y., harbor at, improvement of	382				2018	

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Saco River, Me., breakwater at mouth of	28 598					
Saco River, Me., improvement of	28 599					
Sacramento River, Cal., Board on improvement of	396				2990	
Sacramento River, Cal., improvement of	396				2987	
Sacramento River, Cal., investigation of mining-débris question	399				2996	
Sacramento River, Cal., mouth of, survey of	389				2947	
Sag Harbor, Suffolk County, N. Y., examination and survey for breakwater at	81 859					
Saginaw River, Mich., improvement of	351				2772	
Saginaw River, Mich., injury to revetment in						3871
St. Anthony Falls, Minn., Mississippi River above, improvement of	268			2192		
St. Augustine Harbor, Fla., establishment of harbor lines in	18 425		1685			
St. Augustine Harbor, Fla., examination of channel in	195		1671			
St. Augustine Harbor, Fla., improvement of	188		1630			
St. Charles Bay, Tex., examination for removing obstructions at mouth of	235		1942			
St. Clair Flats Canal, Mich., improvement of	356				2784	
St. Clair Flats Canal, Mich., injury to pier at						3872
St. Clair Flats Canal, Mich., operating and care of	358				2787	
St. Clair, Madison and St. Louis Belt Railroad Company, bridge of, across Mississippi River at Alton, Ill.	432					
St. Clair River, Mich., Corsica Shoal in lower end of Lake Huron near, examination of	363				2820	
St. Clair River, Mich., removal of wrecks in	361				2801	
St. Croix Lake, Wis., near Hudson, examination of	274			2218		
St. Croix River, Me., improvement of	19 570					
St. Croix River, Wis. and Minn., improvement of	271			2205		
St. Croix River, Wis. and Minn., survey for reservoirs at sources of				2214		
St. Francis River, Ark., improvement of	255			2059		
St. Francis River, Mo., improvement of	256			2062		
St. Jerome Bay, Md., examination of	145	1278				
St. Johns River, Fla., improvement of	185		1612			
St. Johns River, Fla., upper part of, south of Lake Monroe; and from Jacksonville to Sanford, examination of	195		1666			
St. Jones River, Del., improvement of	122	1165				
St. Joseph Harbor, Mich., improvement of	343				2702	
St. Joseph River, Mich., improvement of	343				2705	
St. Lawrence River, N. Y., shoal between Sister Islands and Cross-over Light in, improvement of	383				2922	
St. Leonard Creek, Md., examination of	145	1277				
St. Louis Bay and adjacent waters, Minn. and Wis., establishment of harbor lines in	18 426			2515		
St. Louis Bay, Wis., and Fond du Lac, Minn., St. Louis River between Grassy Point in, examination and survey of	317					
St. Louis Bay, Wis., improvement of	312			2495		
St. Louis Harbor, Mo., improvement of	260			2109		
St. Louis River, Minn. and Wis., between Fond du Lac and Grassy Roint, examination and survey of	317					
St. Martinsville, La., and Port Barre, Bayou Teche between, examination of	230		1852			
St. Marys Falls Canal dry dock, Mich	346				2758	
St. Marys Falls Canal, Mich., occupancy of and injuries to public works, etc., at						3803
St. Marys Falls Canal, Mich., operating and care of	346				2724	
St. Marys River, Mich., Hay Lake Channel, improvement of	347				2758	
St. Marys River, Mich., improvement of	345				2712	
St. Paul, Minn., bridge of city of, across Mississippi River	430					
St. Paul, Minn., gauging Mississippi River at or near	273			2214		
Salamander (schooner), removal of wreck of	93 937					
Salem Harbor, Mass., improvement of	38 639					
Salem, Mass., North River at, examination of	46 668					
Salisbury, Mass., bridge across Powow River at	427					
Salkahatchie River, S. C., improvement of	178	1462				

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Samamish, Lake, Wash., ship canal to connect Puget Sound with, examination for..	412					
San Diego Harbor, Cal., improvement of ...	392				2900	
San Diego Harbor, Cal., occupancy of levee at						3673
San Francisco Harbor, Cal., and adjacent waters, establishment of harbor lines in ..	18 426				2948	
San Francisco Harbor, Cal., and adjacent waters, survey of	389				2947	
San Francisco Harbor, Cal., construction of casemates at	6					
San Francisco Harbor, Cal., defense of	5 8					
San Joaquin River, Cal., improvement of...	394				2981	
San Joaquin River, Cal., investigation of mining-débris question	399				2906	
San Joaquin River, Cal., mouth of, survey of.	389				2947	
San Luis Obispo Harbor, Cal., improvement of	391				2965	
San Pablo Bay, Cal., survey of	389				2947	
San Pedro, Wilmington Harbor, Cal., establishment of harbor lines at	18 426				2976	
San Rafael River, Cal., examination of.....	393				2963	
San Simeon Bay, Cal., examination of	393				2971	
Sand Beach, Lake Huron, Mich., harbor of refuge at	353				2776	
Sandusky City Harbor, Ohio, improvement of.	366				2837	
Sandusky River, Ohio, improvement of.....	366				2840	
Sandy Bay, Cape Ann, Mass., harbor of refuge at	36 632					
Sanford and Jacksonville, Fla., St. Johns River between, examination of	195		1666			
Santa Cruz, Cal., harbor of refuge at, examination of	393				2963	
Santee River, S. C., improvement of	173	1458				
Sapelo and Doboy, Ga., inside route between, examination and survey of	185					
Saranac River, N. Y., inner bay near mouth of, at Plattsburg, examination of	388				2938	
Sarasota Bay, Fla., improvement of	191		1651			
Saratoga Passage, Wash., and Padilla Bay, water way through Swinomish Slough connecting, examination and survey of....	411					
Saugatuck Harbor, Mich., improvement of .	342				2929	
Saugatuck River, Conn., examination of....	80 840					
Saugerties Harbor, N. Y., improvement of.	82 879					
Savannah, Ga., and Fernandina, Fla., inside route between, examination and survey of.	185					
Savannah River and Harbor, Ga., improvement of	179		1491			
Savannah River and Harbor, Ga., removal of wrecks in	184		1602			
Savannah River, Ga., below Augusta, bridge obstructing	435					
Savannah River, Ga., improvement of	180		1519			
Savannah River, near Sister Ferry, Effingham County, Ga., bridging	429					
Sayville, N. Y., Browns Creek at, improvement of	79 828					
Schuylkill River, Pa., improvement of.....	112	1069				
Scituate Harbor, Mass., improvement of....	43 658					
Sea walls and embankments at Davids and Governors islands, New York Harbor	6 9 521 524					
Seattle and Northern Railroad Company, bridge of, obstructing Swinomish Slough, Wash	433					
Seattle, Wash., bridging Duwamish River near	431					
Sebewaing, Mich., Sebewaing River below, examination of	362				2804	
Sebewaing River, Mich., below Sebewaing, examination of	362				2804	
Seven Devils mining district, Idaho, and Huntington Bridge, Upper Snake River between, examination and survey of.....	411				3285	
Sevierville, Tenn., Little Pigeon River below, examination of	285			2287		
Shark River, N. J., examination of	118	1062				
Shaw Cove, New London Harbor, Conn., examination of	79 833					
Sheboygan Harbor, Wis., improvement of..	323			2543		
Sheepshead Bay, N. Y., improvement of.....	96	982				
Sherman, Gen. W. T. (schooner), removal of wreck of	118	1090				

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Ship canal connecting Lakes Union, Washington, and Samamish with Puget Sound, Wash., examination for	412					
Ship channel between Port Townsend Bay and Oak Bay, Puget Sound, Wash., examination for	409				3260	
Ship channel in connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, examination of	362				2810	
Ship channel in Galveston Bay, Tex., improvement of	232		1906			
Ship Island Harbor, Miss., removal of wreck in	228		1837			
Shoal between Sister Islands and Cross-over Light, St. Lawrence River, N. Y., improvement of	383				2922	
Shoal Harbor and Compton Creek, N. J., improvement of	105	1004				
Shoalwater Bay, Wash., examination of	409				3266	
Shreveport, La., and Jefferson, Tex., Cypress Bayou and the lakes between, survey of	248			2021		
Shrewsbury River, N. J., improvement of	106	1007				
Sioux City, Iowa, and Fort Benton, Mont., Missouri River between, examination and survey of	277			2242		
Sioux City, Iowa, and Great Falls, Mont., Missouri River between, improvement of	275			2232		
Sister Ferry, Ga., bridging Savannah River near	429					
Sister Islands and Cross-over Light, N. Y., shoal in St. Lawrence River between, improvement of	383				2922	
Sites for fortifications	5					
Siuslaw River, Oregon, improvement of	402				3173	
Skagit Bay, Wash., and Padilla Bay, water way through Swinomish Slough connecting, examination and survey of	411					
Skagit River, Wash., examination of	410				3271	
Skagit River, Wash., improvement of	408				3238	
Skamokawa River, Wash., examination of	420				3378	
Sladesville, N. C., to Pungo River, water way from, examination of	170	1418				
Smith Creek, Md., examination of	146	1282				
Smithland Harbor, Ky., examination of	285			2289		
Smyrna River, Del., improvement of	121	1162				
Smyrna River, Del., removal of wreck in	131	1201				
Snake River (Upper), Idaho, between Huntington Bridge and Seven Devils mining district, examination and survey of	411				3285	
Snake River, Wash., improvement of	405				3210	
Snohomish River, Wash., examination of	410				3271	
Snohomish River, Wash., improvement of	408				3238	
Snoqualmie River, Wash., improvement of	408				3238	
Sopelo, Ga. (*See* Sapelo.)						
South Bend, Wash., Shoalwater Bay and Willapah River at, examination and survey of	400				3266	
South Bound Railroad Company, bridge of The, across Savannah River, Ga	429					
South Dakota, north line of, and mouth of Big Sioux River, Missouri River between, examination and survey of	277			2242		
South Fork of Cumberland River, Ky., improvement of	285			2286		
South Haven Harbor, Mich., improvement of	342				2700	
South Pass of Mississippi River, inspection of improvement of	19 221		1805			
South River, N. J., improvement of	103	999				
Spokane and Palouse Railway Company, bridge of, across Clearwater River, Idaho	431					
Spottsville, Ky., bridge obstructing Green River at	434					
Spuyten Duyvil Creek, N. Y., bridge obstructing	435					
Squan River, N. J. (*See* Manasquan River.)						
S. S. Bickmore (schooner), removal of wreck of	62 732					
Stamford Harbor, Conn., examination and survey of	80 848					
Stamford Harbor, Conn., improvement of	72 795					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Starve Goat Island, R. I., channel between, and mainland, in Narragansett Bay, examination of	62 733					
Staten Island and New Jersey, channel between, improvement of	98	986				
Staten Island, N. Y., Princess Bay, examination of	107	1013				
Staunton River, Va., improvement of	153	1328				
Steele Bayou, Miss., improvement of	244			2005		
Steilaquamish River, Wash., improvement of	408				3238	
Stonington, Conn., harbor of refuge at	60 728					
Stony Creek River, at Stony Creek, Conn., examination of	79 831					
Strait of Karquines, Cal., survey of	389				2947	
Stubbs Ferry, Mont., canyon next below, and Great Falls, Missouri River between, examination and survey of	278					
Sturgeon Bay Canal, Wis., harbor of refuge at entrance of	321			2536		
Sucarnochee River, Ala., examination of	221		1800			
Sudduth Bluff, Tex., and Sabine Lake, Sabine River between, examination of	230					
Suisun Bay, Cal., survey of	389				2947	
Sullivan Falls, Hancock County, Me., examination of	33 619					
Sumpawanna Inlet, N. Y., improvement of	94	978				
Superior Bay and adjacent waters, Minn. and Wis., establishment of harbor lines in	18 426			2515		
Superior Bay, Wis., improvement of	312			2496		
Superior, Lake, purchase of canals connecting Portage Lake, Mich., with	17					
Superior, Wis., Allouez Bay and Nemadji River at, examination of	316			2512		
Superior, Wis., Minnesota Point at, improvement of	313			2499		
Supervision of the harbor of New York	422				3393	
Survey of northern and northwestern lakes	445					3927
Surveys and examinations	17					
Surveys, examinations, and contingencies of rivers and harbors, estimates for	421					
Surveys in military departments, estimates for	450					
Susquehanna River above and below Havre de Grace, Md., improvement of	124	1181				
Susquehanna River above Havre de Grace, Md., examination and survey of	132					
Susquehanna River, West Branch of, Pa., examination of	118	1102				
Suwanee River, Fla., improvement of	194		1063			
Swan Island, Oregon, Willamette River on west side of, examination of	420				3373	
Swansboro and New River, N. C., water way between, improvement of	162	1376				
Swinomish Slough, Wash., bridge obstructing	433					
Swinomish Slough, Wash., examination and survey of	411					
Sylvia de Grasse (ship), removal of wreck of	420				3373	
T.						
Tacoma, Olympia and Grays Harbor Railroad Company, bridges of, across Chehalis and Johns rivers, Wash	430					
Tallahatchee River, Miss., improvement of	244			2003		
Tallapoosa River, Ala., improvement of	206		1741			
Tampa Bay, Fla., improvement of	192		1055			
Tangier Harbor, Va., examination of	131	1207				
Tar River, N. C., improvement of	157	1347				
Taunton River, Mass., improvement of	53 707					
Taylorsville, Ohio, bridge obstructing Muskingum River at	434					
Tchefuncte River, La. (*See* Chefuncte River.)						
Tchula Lake, Miss., improvement of	244			2001		
Teche, Bayou, La., between St. Martinsville and Port Barre, examination of	230		1852			
Teche, Bayou, La., improvement of	226		1828			
Tennessee River:						
Bridge at Florence, Ala., obstructing	435					
Improvement of	278			2252		

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Tennessee River—Continued.						
Improvement of, above Chattanooga, Tenn	278			2252		
Improvement of, below Bee Tree Shoals, Ala	279			2255		
Improvement of, below Chattanooga, Tenn	287			2311		
Improvement of, between Chattanooga, Tenn., and foot of Bee Tree Shoals, Ala	286			2303		
Operating and care of Muscle Shoals Canal	287			2322		
Tensas River, La., improvement of	241			1989		
Terre Haute, Ind., and La Fayette, Wabash River between, examination of	298			2411		
Terrebonne, Bayou, La., and Bayou Black, examination for connection between	229		1846			
Terrebonne, Bayou, La., between Houma and Thibodeaux, examination of	229		1843			
Terrebonne, Bayou, La., improvement of	224		1823			
Texas and Pacific Railway Company, bridge of, obstructing Bayou Plaquemine, La	434					
Thames River, Conn., improvement of	63	742				
The Board of Engineers	11					
The South Bound Railroad Company, bridge of, across Savannah River, Ga	429					
The Upper Bridge Company, bridge of, across Monongahela River, Pa	432					
Thibodeaux, La., and Houma, Bayou Terrebonne between, examination of	229		1843			
Thoroughfare from Cape May to Great Bay north of Atlantic City, N. J., examination of	118		1097			
Thunder Bay Harbor, Mich., improvement of	348				2765	
Thunder Bay River, Mich., improvement of	350				2768	
Tickfaw River, La., and its tributaries, improvement of	222		1819			
Ticonderoga River, N. Y., improvement of	387				2936	
Tigre, Bayou, La., examination of	229		1841			
Tillamook Bay and Bar, Oregon, examination and survey of	411					
Tillamook Bay and Bar, Oregon, improvement of	404				3200	
Tionesta Creek, Pa., between Tionesta and Balltown, examination of	294			2381		
Tionesta, Pa., and Balltown, Tionesta Creek between, examination of	294			2381		
Titusville and Jupiter Inlet, Fla., Indian River between, examination of	195		1673			
Toledo Harbor, Ohio, improvement of	364				2828	
Tombigbee River, improvement of:						
Below Demopolis, Ala	214		1783			
Below Vienna, Ala	214		1781			
Between Demopolis, Ala., and Columbus, Miss	215		1783			
Between Fulton, Miss., and Vienna, Ala	213		1780			
Between Walker Bridge and Fulton, Miss	213		1779			
Toms River, N. J., examination and survey of	119		1114			
Tonawanda Harbor, N. Y., improvement of	376				2884	
Tongue River, Mont., near Miles City, examination of	277			2237		
Tongue River, Mont., Yellowstone River below mouth of, examination of	277			2239		
Torpedo experiments	550					
Torpedoes for harbor defense	552					
Totten Bay, Devil Lake, N. Dak., examination of	274			2221		
Town River, Mass., examination and survey of	47	679				
Tradewater River, Ky., improvement of	304			2423		
Tremble, M. E. (schooner), removal of wreck of	861				2901	
Trent River, N. C., improvement of	158		1355			
Trinity River, Tex., below Dallas, examination of	235		1936			
Trinity River, Tex., improvement of	233		1918			
Trout Creek, Fla., bridge obstructing	435					
Tug Fork, Big Sandy River, 91 and 95½ miles above Catlettsburg, Ky., bridging	431					
Tug Fork, Big Sandy River, W. Va. and Ky., improvement of	308			2467		

Digitized by Google

Subject.	Page. Part I.		Part II.	Part III.	Part IV.	Part V.	Part VI.
Tumwater, Wash., Olympia Harbor to, examination and survey of	411						
Turner Creek, Md., examination and survey of	132		1211				
Tuscaloosa and Daniels Creek, Ala., Black Warrior River between, improvement of	215			1784			
Two Rivers Harbor, Wis., improvement of	322				2543		
U.							
Umpqua River, Oregon, improvement of	402					3169	
Union, Lake, Wash., ship canal to connect Puget Sound with, examination for	412						
United States Engineer School	15	539					
Upper Bridge Company, bridge of The, across Monongahela River, Pa	432						
Upper Columbia River, Oregon and Wash., improvement of	405					3210	
Upper Falls, La., bridging Red River at	430						
Upper Machodoc Creek, Va., examination of	146		1230				
Upper Mississippi River, operating snag boats and dredge boats on	264				2137		
Upper Snake River, Idaho, between Huntington Bridge and Seven Devils mining district, examination and survey of	411					3285	
Urbana Creek, Va., improvement of	142		1268				
Use of public works by corporations or individuals	19	430					3865
V.							
Vacherie, La., etc., and Lake des Allemands, bayous Chevreuil and Tigre between	229			1841			
Vallette Dry Dock, removal of wreck of	231			1869			
Van Buren, Mo., Current River below, examination of	257				2065		
Vancouver, Wash., and mouth of Willamette River, Oregon, Columbia River between, examination and survey of	421						
Vancouver, Wash., bridging Columbia River near	429						
Vermillion, Bayou, bay and passes, La., examination of	230			1855			
Vermillion Harbor, Ohio, improvement of	368					2847	
Vidal, Bayou, La., improvement of	242				1902		
Vienna, Ala., and Fulton, Miss., Tombigbee River between, improvement of	213			1780			
Vienna, Ala., Tombigbee River below, improvement of	214			1781			
Vincennes, Ind., Wabash River above, improvement of	297				2407		
Vincennes, Ind., Wabash River below, improvement of	297				2403		
Vineyard Haven Harbor, Mass., improvement of	50	700					
Volusia Bar, Fla., improvement of	187			1627			
W.							
Wabash River, Ind. and Ill., above Vincennes, improvement of	297				2407		
Wabash River, Ind. and Ill., below Vincennes, improvement of	297				2402		
Wabash River, Ind. and Ill., improvement of	297				2402		
Wabash River, Ind., between Terre Haute and Lafayette, examination of	298				2411		
Waccamaw River, to Waccamaw Lake, N. C. and S. C., improvement of	170		1442				
Waco, Tex., Brazos River below, examination of	235						
Walker Bridge and Fulton, Miss., Tombigbee River between, improvement of	213			1779			
Wappinger Creek, N. Y., improvement of	84	885					
Wappoo Cut, S. C., improvement of	176		1477				
War maps, estimates for publication of	450						
Wareham Harbor, Mass., improvement of	50	701					
Warrior River, Ala., improvement of	212			1776			
Warsaw, Ill., Mississippi River at, examination of	264				2131		
Warwick River, Md., examination and survey of	132		1218				
Washington Aqueduct, maintenance and repair of	436						3575

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Washington Bayon, Miss., improvement of	244			2005		
Washington, D. C.:						
Construction of casemates at	6					
Defense of	5 7					
Examination and survey of Potomac River below	146					
Improvement and care of public buildings and grounds	444					3907
Improvement of Potomac River at	135	1246				
Increasing water supply of	442					3904
Maintenance and repair of Washington Aqueduct	436					3875
Maintenance of Washington Monument	444					3907
Water supply of	441					3897
Washington Harbor, Pamlico River, N. C., examination of	170	1429				
Washington, Lake, Wash., ship canal to connect Puget Sound with, examination for	412					
Washington Monument, Washington, D. C., maintenance of	444					3907
Watch Hill Cove, Little Narragansett Bay, R. I., examination of	62 735					
Water gauges on Columbia River, Oregon and Wash	419				3372	
Water gauges on Mississippi River and its principal tributaries	246			2014		
Water gauges on Mississippi River at or near St. Paul, Minn	273			2214		
Water supply, District of Columbia	441					3897
Water supply of Washington, D. C., increasing	442					3904
Wateree River, S. C., between Camden and Falls of the Catawba, and bend about 4 miles below Camden, examination of	179	1487				
Wateree River, S. C., improvement of	174	1462				
Waterville to Augusta, Me., Kennebec River from, examination and survey of	33					
Water ways:						
Between Beaufort Harbor and New River, N. C., improvement of	162	1372				
Between Cape May and Great Bay north of Atlantic City, N. J., examination of	118	1097				
Between Chincoteague Bay, Va., and Delaware Bay, at or near Lewes, Del., improvement of	123	1168				
Between Doboy and Sapelo, Ga., examination and survey of	185					
Between Jamaica Bay and Long Beach Inlet, N. Y., examination and survey of	94					
Between Jefferson, Tex., and Shreveport, La., and Cypress Bayou, survey of	248			2021		
Between Lynn Haven Bay and Eastern Branch of Elizabeth River, Va., examination of	153	1310				
Between New Berne and Beaufort, N. C., improvement of	160	1363				
Between New River and Swansboro, N. C., improvement of	162	1376				
Between Norfolk Harbor, Va., and Albemarle Sound, N. C., improvement of	151	1302				
Between Pamlico River and Bay River, N. C., examination of	170	1421				
Between Port Townsend Bay and Oak Bay, Puget Sound, Wash., examination for	409				3260	
Between Pungo River and Sladesville, N. C., examination of	170	1418				
Between Savannah, Ga., and Fernandina, Fla., examination and survey of	185					
Connecting Lakes Union, Washington, and Samamish with Puget Sound, Wash., examination for	412					
In connecting waters of the Great Lakes, between Chicago, Duluth, and Buffalo, examination of	362				2810	
Near Coaster Harbor Island, R. I., improvement of	57 718					
Waukegan Harbor, Ill., improvement of	327			2568		
Wellfleet Harbor, Mass., improvement of	44 603					
West Bay, West Galveston Bay, Tex., channel through, examination and survey of	225					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
West Galveston Bay, Tex., from Christians Point, for reopening channel through West Bay, examination and survey of	235					
West Liberty, Ky., and Farmer, Licking River between, improvement of	306			2462		
West Neck River, Va., examination of	153	1324				
West Point, Ga., and Franklin, Ala., Chattahoochee River between, examination of	211		1756			
Westchester Creek, N. Y., examination and survey of	94 954					
Western branch of Elizabeth River, Va., examination of	153	1307				
Weston, Mo., Missouri River at, examination of	275			2229		
Westport Harbor, Mass., improvement of	52 706					
Wetumpka, Ala., Alabama River up to, examination of	211		1761			
Wetumpka, Ala., and East Tennessee, Virginia and Georgia Railroad bridge, Coosa River between, improvement of	208		1748			
Weybosset (schooner), removal of wreck of	61 731					
Weymouth Back River, Mass., examination and survey of	47 682					
Weymouth River, Mass., improvement of	42 655					
White Oak River, N. C., between Roberts Landing and Collins Crossing, examination of	170	1434				
White River, Ark., improvement of	252			2048		
White River, Ark. (Lower), examination and survey of	257					
White River Harbor, Mich., improvement of	339				2687	
White River, Ind., improvement of	298			2409		
Whitehouse, Josiah (schooner), removal of wreck of	61 732					
Wicomico (Great) River, Va., examination of	146	1288				
Wicomico River, Md., improvement of	128	1193				
Wicomico River, Newport Creek at head of, Md., examination of	146	1281				
Willamette River, Oregon:						
Examination and survey of, at Clackamas Rapids, Ross Island, and Corvallis	421					
Examination and survey of, below Portland	421					
Examination and survey of Columbia River between Vancouver, Wash., and mouth of	421					
Examination of, on west side of Swan Island	420				3373	
Improvement of, above Portland	417				3368	
Improvement of, below Portland	416				3362	
Willapah River, Wash., below Woodward Landing, examination and survey of	409				3266	
Willets Point, N. Y., post of	15 537					
Willow River, Wis., near Hudson, examination of	274			2218		
Willow Slough, Ill., reopening				2124		
Willsboro, N. Y., Boquet River below, examination of	388				2940	
Wilmington Harbor, Cal., establishment of harbor lines at San Pedro	18 426				2976	
Wilmington Harbor, Cal., improvement of	391				2956	
Wilmington Harbor, Del., improvement of	119	1136				
Wilmington Harbor, Del., survey for improvement of	120	1138				
Wilmington, N. C., Cape Fear River above, improvement of	165	1390				
Wilmington, N. C., Cape Fear River at and below, improvement of	166	1394				
Wilson Creek, Va., and Greenbrier River, W. Va., New River between mouths of, improvement of	302			2430		
Wilson Harbor N. Y., improvement of	376				2691	
Wilson Point Harbor, Conn., improvement of	71 789					
Winfield, Richard M., *et al.*, bridge of, in Barnstable, Mass	431					
Winona and Southwestern Railway Company, bridge of, across Mississippi River at Winona, Minn	427					
Winona, Minn., bridge of city of, across Mississippi River	431					
Winona, Minn., bridging Mississippi River at	427 431					

Digitized by Google

Subject.	Page. Part I.	Part II.	Part III.	Part IV.	Part V.	Part VI.
Winthrop Harbor, Mass., improvement of	49 644					
Winyaw Bay, S. C., improvement of	160	1411				
Wisconsin River, Wis., improvement of	328			2572		
Wisconsin River, Wis., survey for reservoirs at sources of				2214		
Withlacoochee River, Fla., improvement of	193		1050			
Woods Landing, Oregon, and Astoria, Columbia River between, examination for snagging	420				3380	
Woodward Landing, Wash., Willapah River below, examination and survey of	409				3266	
Works, occupancy of and injury to public, by corporations or individuals	19 436					3865
Wrecks, removal of	17					
At Elizabethport, N. J., near entrance to Arthur Kill	107	1013				
At Pollock Rip Shoals, Mass	61 731					
In Barnegat Inlet, N. J	118	1090				
In Chesapeake Bay		1201				
In Columbia River near Astoria, Oregon	420				3373	
In Delaware Bay	118	1090				
In Delaware Bay and River	118	1090				
In Hyannis Harbor, Mass	62 732					
In Jackson Creek, Chester River, Md	131	1201				
In New Orleans Harbor, La	231		1800			
In New York Harbor, N. Y	93 937					
In Ogeechee River, Ga			1605			
In Pamlico River, N. C., opposite Swan Point	169	1417				
In Pleasant River, Me	32 610					
In Portland Harbor, Me	32 609					
In Rancocas River, N. J		1090				
In Raritan Bay, N. J	93 937					
In St. Clair River, Mich	361				2801	
In Savannah River and Harbor, Ga	184		1602			
In Ship Island Harbor, Miss	228		1837			
In Smyrna River, Del	131	1201				
In South Channel across bar, Charleston Harbor, S. C	178	1487				
Near Gay Head Light	61 732					
Near Handkerchief Light-ship	61 731					
Wrightsville and Tennille (Tennville) Railroad Company, bridge of, across Oconee River, Ga	429					
Wyandotte County, Kans., bridging Missouri River at	432					
Y.						
Yadkin River, N. C., improvement of	167	1404				
Yamhill River, Oregon, below McMinnville, examination and survey of	421				3381	
Yaquina Bay, Oregon, improvement of	403				3182	
Yazoo River, Miss., improvement of	243			1900		
Yellow Banks, Chippewa River, Wis., improvement of	270			2201		
Yellow River, Ga., from bridge near Covington to Ocmulgee River, examination of	184		1003			
Yellowstone National Park, construction and improvement of roads and bridges in	447					3331
Yellowstone River, Mont. and N. Dak., improvement of	276			2236		
Yellowstone River, Mont., below mouth of Tongue River, examination of	277			2239		
York Harbor, Me., improvement of	29 602					
York River, Va., improvement of	143	1270				
Yonghiogheny River, Pa., at McKeesport, bridging	431					
Youngs Bay, Oregon, channel in, examination of	420				3376	
Youngs River, Wash., improvement of	419				3371	
Yuma, Ariz., and Eldorado Cañon, Colorado River between, examination of	393				2974	
Z.						
Zanesville, Ohio, bridge obstructing canal of Muskingum River at foot of Main street	434					

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

ITY OF MICHIGAN

Digitized by Google

Digitized by Google

UNIVERSITY OF MICHIGAN
3 9015 06716 9980

Digitized by Google